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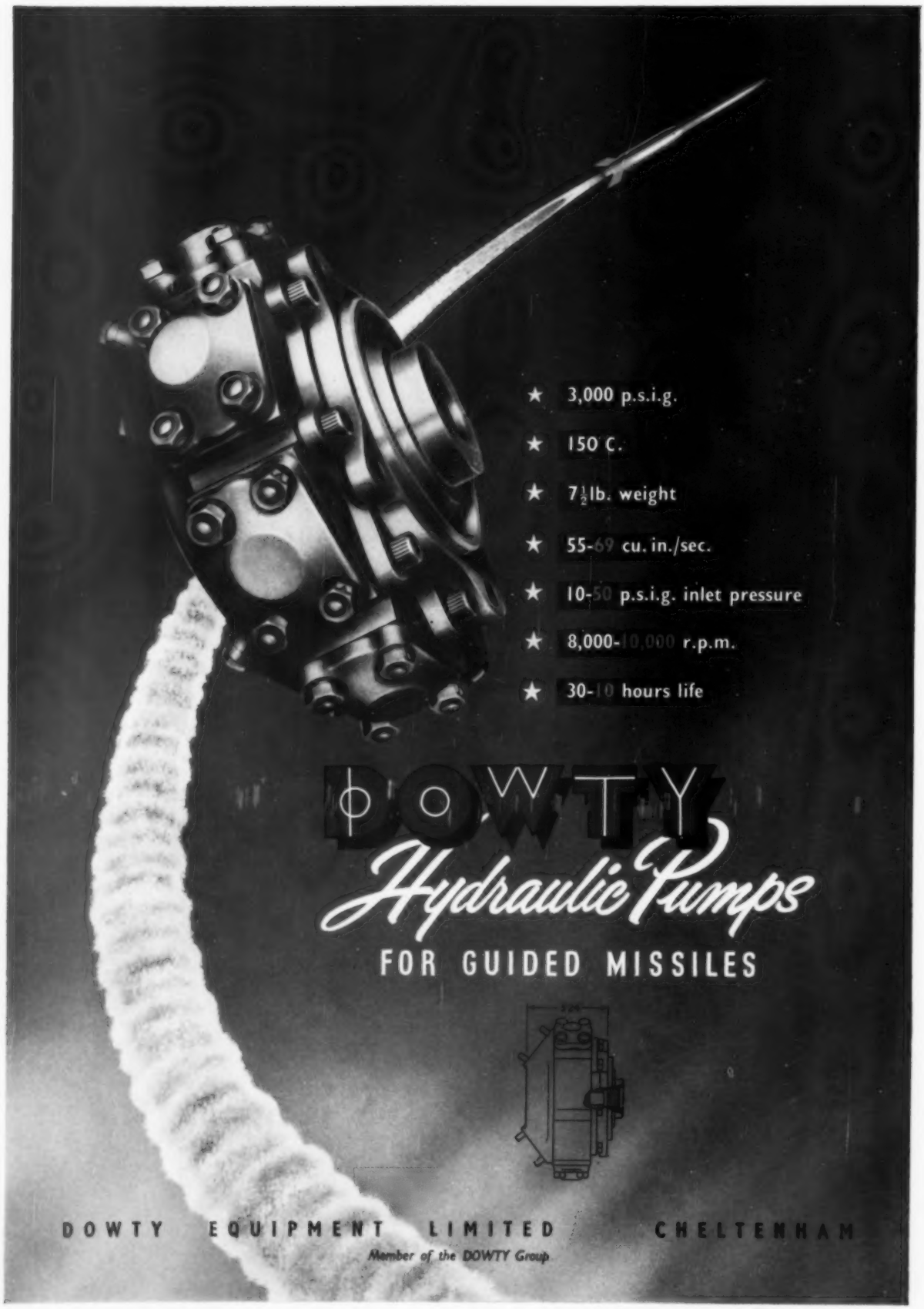
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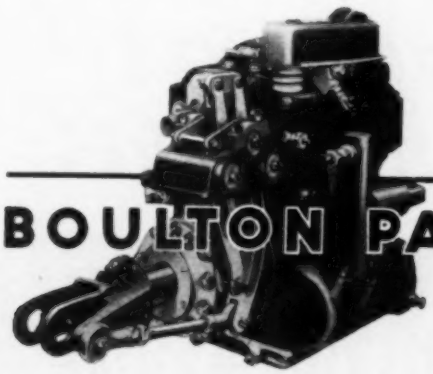

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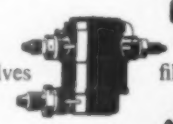
Fuel Tank Pressurisation Systems, designed to meet various operational requirements such as nitrogen blanketing and tank pressurisation, include servo and non-servo systems using servo control valves pressure reducing valves  filter/restrictor valves air or air/nitrogen control valves servo and direct acting vent valves.

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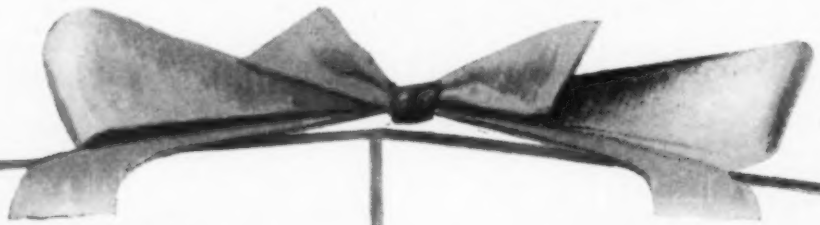

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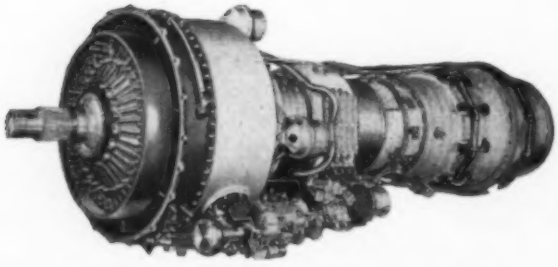

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

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and
AIRCRAFT ENGINEER

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Archetypes in Aeronautics

WE touched last week on some technical aspects of Dr. Lachmann's paper *The Aircraft Designer's Dilemma.* Following a distinctively Handley Page tradition that same paper was rich in picturesque and (need we add?) biblical allusion; and from it we take our text this week. We begin at a point where Dr. Lachmann reached back into his youth to recall a certain Inspector of the German Air Force who, in a special order, admonished dilatory pupils at the flying schools. This order culminated in the prediction that the aviator of the future would have to be a hybrid, based on the circus director Rentz (a counterpart of Bertram Mills); the scientist Einstein; and the Indian goddess Durga—a many-armed and horrible deity of destruction, but one who was also revered as a benefactress.

In later years Dr. Lachmann had often reflected how prophetic this order had proved; for here, in terms of Jung's psychology, were three archetypes. First, the circus director—representing the ebullient entrepreneur (a type who had contributed decisively to the rapid growth of aviation). Second, the scientist—symbolic of how the scientific approach permeated "the engineering art of aircraft design." And last, the goddess "whose many arms are not only symbolic of a capacity to deal with the ever increasing complexity of aircraft design, construction and operation, but also of the ambivalence of destruction and the common good which can be purpose and function of the aeroplane."

But even this wondrously compounded figure failed to satisfy completely the exacting imagination of Handley Page's director of scientific research; for he himself saw fit to add another archetype—the prophet Elijah. He did this not because Elijah foresaw for his fiery chariot the use of rockets, and jets with afterburners, but because he was a prophet, and because—in all seriousness—vision, or a kind of technical second sight, was essential in the business of aircraft design.

"It would be asking for too much," concluded Dr. Lachmann, "to have all these archetypes in the subconscious of one person; but they can be analysed in all successful teams of the aircraft industry in this country and abroad."

Persons and Prophets

A diverting half-hour could certainly be spent in identifying them with particular personalities in our own industry. Immediately there come to mind some half-a-dozen "brilliant entrepreneurs." Britain, indeed, is especially well endowed with men of this stamp. In scientists, we are told, there is a marked deficiency; but we believe that such as we have are no less in stature for being British than if they were Russian or American. As for the many-armed ones—the grapplers with the hydra-headed complexities of design, construction and operation—these have always grown sturdily in our islands. So sturdily, indeed, that we are persuaded to doubt Dr. Lachmann's belief that it is asking too much to have all the archetypes "in the subconscious of one person." We could name one man at least whose interests and accomplishments commend him very strongly for just that distinction.

All in all, then, we need have little fear of a spectral visitation from the erstwhile Inspector of the German Air Force. It is, however, Dr. Lachmann's Elijahs who can best serve our industry in these times of ruthless commercial and technical competition—those especially who bear aloft the fiery symbols BLC, VTOL and STOL. We can think of one "ebullient entrepreneur" in British aviation who would willingly exchange a whole bevy of scientists for a "man of ideas" (as he names his conception of a prophet). That we do possess such men is proved by developments like the Rolls-Royce Bedstead, the Short SC.1 and Saunders-Roe SR.53, the Griffith supersonic jet-lift delta proposal, the principles of the jet flap and jet deflection, the steam catapult, the angled deck—and doubtless by many another development in the shrouded world of missiles.

The Elijahs are still among us. But if they pass unhonoured in their own country, whether by tardy recognition or scant encouragement, some grim visitation will surely befall.

FROM ALL QUARTERS

R.Ae.C. Honours Pioneers

AN outstanding occasion in the history of the Royal Aero Club took place last Tuesday evening, when a house dinner was given to honour pioneers and leaders in British aviation. The Duke of Edinburgh's name headed the list of guests, which included Lord Brabazon, Sir Geoffrey de Havilland, Sir Frederick Handley Page, Sir Alliott Verdon Roe, H. Oswald Short, Sir Thomas Sopwith and Claude Grahame-White. There was a capacity attendance of almost a hundred members.

Ferranti's Royal Visitor

DURING his visit to Manchester last Friday, when he opened an extension to the College of Science and Technology, the Duke of Edinburgh toured the Ferranti guided weapons establishment at Wythenshawe and there saw some of the work involved in the guidance and control system of the Bristol-Ferranti Bloodhound.

Prince Philip was welcomed by Sir Vincent de Ferranti, chairman of the company; and Dr. N. H. Searby, manager of the establishment, conducted the royal visitor round the laboratories and workshops.

The Duke saw some secret films detailing the Bloodhound system, and the latest firing results were explained to him. At the end of his tour he inspected a Bloodhound on its launcher, set up under cover in the grounds.

P.1 Flying Time

THAT more than 700 flights have been made by P.1s, mostly at supersonic speed, since the prototype exceeded Mach 1 in level flight during August 1954, was stated by W/C. R. P. Beamont in a paper due to be given to the Graduates and Students Section of the Royal Aeronautical Society last Wednesday. W/C. Beamont is manager of flight operations and chief test pilot of the English Electric Co., Ltd. We hope to summarize his paper in a forthcoming issue.

The R.Ae.S., incidentally, has announced that the lecture *The Weapon System Concept*, due to be given to the Boscombe Down Branch by Mr. Handel Davies on December 3, has been postponed until December 17.

A. V. Roe Canada Changes

THREE executive vice-presidents have been appointed by A. V. Roe Canada, Ltd., in what is described by the company as "a major realignment of management responsibilities," following the acquisition of Dominion Steel and Coal Corporation, Ltd. The appointments are of Mr. Walter R. McLachlan, president of Orenda Engines, Ltd., as executive vice-president administration and co-ordination; Mr. Fred T. Smye, president of Avro Aircraft, Ltd., as executive vice-president aeronautical; and Mr. A. C. Macdonald, formerly president of Canadian Car, Ltd. (another A. V. Roe subsidiary), as executive vice-president industrial.

SUPER-SUPER-SABRE: The North American F-107A (Pratt and Whitney J75 with afterburner), designed as a U.S.A.F. fighter/bomber capable of more than Mach 2 (see news-item). It is not in production.

Gyron Junior DGJ.10

THE above designation has been officially notified for a new development of the de Havilland Gyron Junior turbojet. A substantial increase in rating might be deduced from the numerical suffix.

IRBMs for NATO

FIRST deliveries of American IRBM to Britain and other European members of NATO are due to be made early in 1959. This was stated by Mr. Neil McElroy, the U.S. Secretary of Defense, on November 19 after a conference with President Eisenhower. Missiles for Britain would be sent before mid-1959, and this country would have "to select and prepare base launching sites."

On the same day the Secretary of State, Mr. John Foster Dulles, was asked about reports that Europe did not want missile bases because these would invite atomic attack.

Mr. Dulles said the United States had no intention of forcing missile bases on countries which did not want them. Gen. Norstad had assured him that they were "very much desired" by Continental members of NATO.

Missile-mounted Cameras

AT this year's S.B.A.C. Exhibition a Williamson camera designed for mounting on a guided missile was shown. It is now disclosed that this instrument was designed specifically for the de Havilland Firestreak and has been used on missiles fired by the D.H. team in Australia.

Request for the development of the camera came in 1955 from de Havilland Propellers, who felt that a better assessment of "miss distance" could be obtained if the apparatus could be mounted on the missile itself instead of on the target aircraft as in conventional practice. In view of the high g loadings involved, and the fact that the camera must be recovered intact by parachute, some formidable problems were posed. The specification demanded (a) 360 deg annular cover and 50 deg forward cover; construction to withstand loads of up to 100 g; and sharp photographic results. It was also necessary for the camera to withstand temperatures up to 100 deg F; after consultations with the Kodak company, and some experiments, this was found to be practicable.

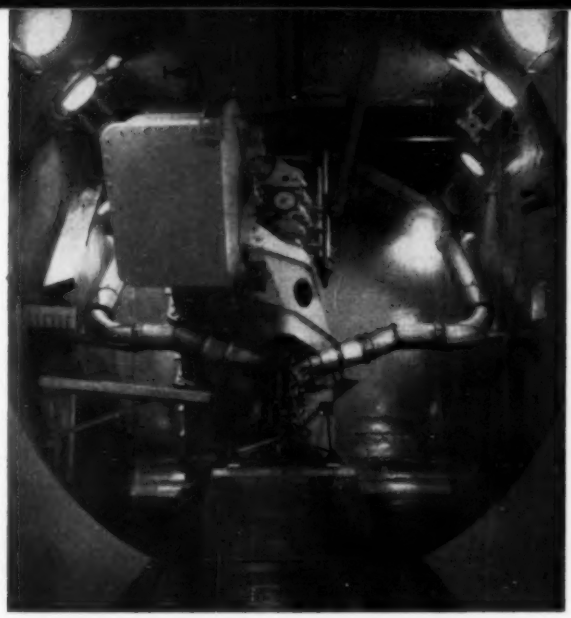
As the design developed it became apparent that the simplest solution was to employ eight small cameras together covering a 360 deg circle, each containing a single-exposure film and all eight shutters being simultaneously triggered. The next problem was to minimize the time delay from the moment of the shutter-release electrical signal being received. A number of techniques were tried, including the use of fusible wire, and eventually it was found that electrically detonated actuating charges would provide the most satisfactory solution.

"Test firing of the camera on the bench was a most alarming sight," say Williamsons, "as the whole system leapt several inches into the air under the reaction of the explosive motors." The company add that the system is capable of development to meet other specialized requirements: the same basic shutter design could be used in a larger or smaller annulus and the number of camera compartments could be reduced by using wide-angle lenses, though these would be rather costly in such an application.

F-107

FEW aircraft are of quite such striking appearance as the F-107, planned by North American Aviation's Los Angeles Division as the logical successor to the F-100 series. Compared with its predecessors, it is slightly larger, much more powerful (the engine is a Pratt and Whitney J75 with afterburner) and has a completely new flight-control system including an "all-flying" rudder and spoiler ailerons. Of particular interest is the fixed-geometry supersonic intake, which occupies an unusual position atop the fuselage behind the canopy. A central knife-edge creates inclined shocks which focus themselves externally along the intake lips; the design required extensive tunnel and rig testing in order to provide satisfactory operation, particularly at high angles of attack.

Originally the company had a limited-production contract from the U.S.A.F. for nine aircraft. Three were completed, the first



ANNUAL AWARDS DAY at the Rolls-Royce Aero Engine Division, with Mr. J. D. Pearson, chief executive and deputy chairman, making presentations to apprentices L. Scholes and A. R. Taylor, and with Mr. P. Haxby, deputy training manager, looking on.

UNIVERSAL TEST-BED for the Napier Gazelle, newly in use at the Coronation Road, Park Royal, branch of Napier's Aero Gas Turbine Division. In the Westland Wessex—described in this issue—the Gazelle is mounted at an angle of 35 deg from the horizontal, and in the Bristol 192 it will operate almost vertically.

flight being early in September last year at Edwards A.F.B. This flight lasted 35 minutes, but the drag 'chute failed on landing, and the aircraft rolled into a ditch, wiping off its nose undercarriage. Later flying was outstandingly successful, Mach numbers between 2.1 and 2.18 frequently being reached. In the spring of 1956 North American's contract was cancelled in favour of the Republic F-105B (*Flight*, May 31, 1957). One of the remaining F-107As has now been turned over to the N.A.C.A. at Edwards A.F.B. for flight research at speeds greater than 1,300 m.p.h.

Alvis Report

IN his statement issued in advance of the Alvis general meeting on December 17 the chairman, Mr. J. J. Parkes, says that prospects for the current year appear promising and that the factory has sufficient orders for aero-engines and vehicles to keep it adequately employed throughout the year ending next July 31. Export business concluded last year was the largest ever in the history of the company.

On the world sales tours undertaken by two Twin Pioneers of Scottish Aviation, Ltd., 46,000 miles' flying and 580 take-offs and landings were made with complete engine reliability, "despite the somewhat strenuous operation which such demonstrations entailed."

Mr. Parkes states that during the past year, in addition to those types of aircraft already equipped with Alvis engines, "some promising overseas prototype installations were made or under development."

The company's trading income for the year, amounting to £427,112, exceeds that for the preceding year by £106,630.

G/C. Wroath Joins Blackburn

After 32 years' service in the R.A.F., during which he was first Commandant (1943-44) of the E.T.P.S. and later Superintendent of Flying at Boscombe Down, G/C. S. ("Sammy") Wroath, C.B.E., A.F.C. and Bar, has joined the sales organization of Blackburn and General Aircraft, Ltd. His R.A.F. career has included two tours in the U.S.A. with the British Air Commission, as a test pilot (1944-45) and on an exchange posting at the Air Proving Ground at Eglin Air Force Base, Florida (1950-51).

Fairey Aviation A.G.M.

REVIEWING Fairey Aviation activities in his speech at the annual general meeting on November 21 the chairman and managing director, Mr. Geoffrey W. Hall, said that sales of the Fireflash had been hampered by an official announcement that the weapon was an interim type. This was not helpful at a time when the company was endeavouring to obtain export orders. Faireys have another weapon project in hand, though for security reasons it was impossible to give details; but the present activities of the weapon division had been appreciably reduced.

Mr. Hall said the Rotodyne had created world-wide interest and its flying trials had gone on at a rate of intensity not normally recorded. In the first eight days 16 flights were made; heights of over 1,000ft and forward speeds exceeding 70 m.p.h. had been achieved and flights away from the aerodrome undertaken. The F.D.2 had continued in use as a highly successful research aircraft; it was a matter of great regret that the Defence White Paper prevented the continued development of this and related aircraft. The Gannet had valuable potential for foreign sales and work was proceeding on the Mk 3 early-warning version which has been ordered by the Ministry of Supply. The Firefly Mk 9 target aircraft continued to give good service.

Among other parent company activities, Mr. Hall referred to envelope tooling and hydraulic power controls; among Fairey subsidiaries he mentioned that Avions Fairey, in Belgium, had after two lean years contributed materially to the group profits. The group's consolidated trading profit, £2,128,353, showed no major alteration from the preceding two years.

Faireys Join Atomic Power Group

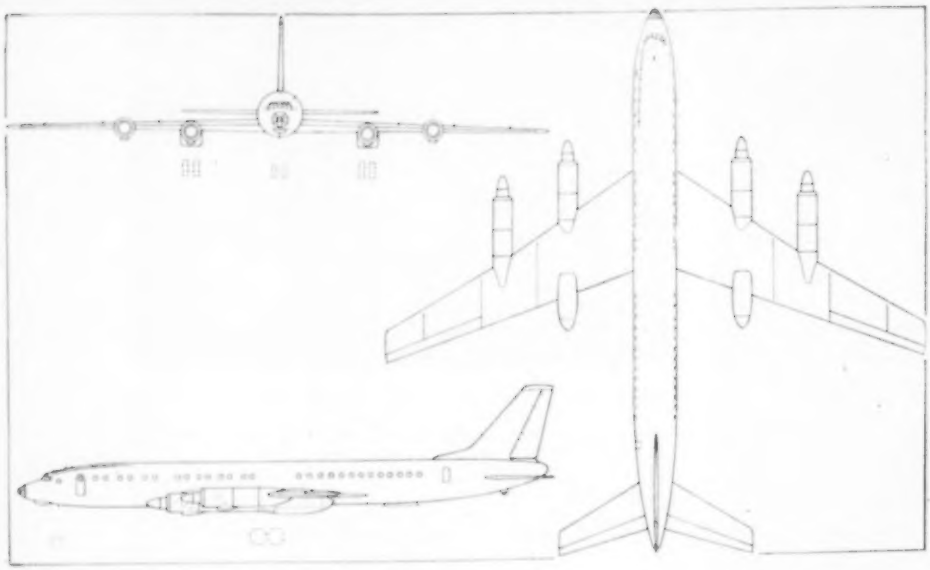
ARRANGEMENTS have been completed between the Fairey Aviation Co., Ltd., and Atomic Power Constructions, Ltd., whereby the company becomes a full member of the fifth atomic group formed recently by agreement with the U.K. Atomic Energy Authority. A Fairey announcement last week about this development said that Mr. G. W. Hall, the chairman and managing director, would be joining the Board of Atomic Power Constructions, Ltd. In addition to Faireys, this concern now includes as members the following companies: Crompton Parkinson, Ltd.; Elliott Brothers (London), Ltd.; International Combustion (Holdings), Ltd.; Nuclear Civil Constructors; and Richardsons, Westgarth and Co., Ltd.

The Fairey Aviation Co., Ltd., has been intimately connected with atomic-energy developments for the past ten years, extensive work having been undertaken for the U.K.A.E.A. both at Hayes and Stockport. Contracts of major importance have been carried out for Springfields, Windscale, Capenhurst, Dounreay and the Calder Hall power station project, in which the company was responsible for producing the fuel containers.

Lighter-than-air Memories

WITH good reason, reminiscence was the keynote of the Lighter-than-air Reunion, held in London last Friday. In the chair was Brig. P. W. L. Broke-Smith, who served under the celebrated Col. J. E. Capper in the operation of Army balloons and kites early in the century and, subsequently, the development of airships at Farnborough from 1906 onwards; and among the guests were W/C. R. S. Booth, captain of the R.33 and R.100, and W/C. Cave-Brown-Cave, who was in charge of R.N.A.S. airship design in 1913. Of the sixty-odd others present, almost every one had been closely connected with British airships at some time in their history.

In addition to Brig. Broke-Smith the *raconteurs* included Lord Ventry, Maj. P. L. Teed (engaged on airship design and construction during World War I and now deputy chief of aeronautical research and development at Vickers-Armstrongs), and the reunion secretary, Mr. J. Fairley. Mr. A. G. Brownsill, manager of the Goodyear airline sales and service department in this country, described a recent visit to Akron to see current airship-manufacturing activities. Apart from the high-performance Goodyear craft in U.S.N. service (he noticed nine moored to Key West) he saw small airships being used for publicity and joy-riding: one, at Miami, was doing a roaring trade with 20-minute flights for eight passengers at a time at $1.20 each.



A provisional drawing of the Tu-114. It is believed that the span is less than the 190ft quoted by Mr. Robertson.

By FRANK ROBERTSON

THE author of this commentary on the new Soviet transports is Mr. F. H. Robertson, A.F.R.Ae.S., who is chief project engineer of Short Brothers and Harland, Ltd. He has been a regular contributor to the "Jet versus Turboprop" controversy in our pages.

RUSSIA'S NEW AIRLINERS

Some Interpretations and Conclusions

DURING the past year a most interesting crop of new transport aircraft has appeared in the U.S.S.R. It is clear that a powerful effort is being made to provide aeroplanes which will not only meet the needs of the Russian domestic airline Aeroflot, but which will prove to be attractive to the various satellite powers and to the other Asian great powers to an extent which will tend to prevent these countries from looking to the West for their aircraft.

Though quite a lot of information has now been published about these aircraft some important gaps still exist in our data. Such parameters as empty weight, wing thickness and profile, engine temperatures and compression ratios and propeller details are still largely unknown. In spite of this, however, it is possible to draw some interesting comparisons and conclusions.

In Table 1 I have written down the important parameters as I know them from various published sources. Perhaps some air-minded reader from behind the iron curtain would care to fill in the blanks.*

It is clear from quite a cursory examination that the two Tupolev designs fall into the same general payload/speed/range bracket as the Comet and Convair 880 and that, provided they have a reliable engineering product, the Russians have very little to fear from competition in this category in their own sphere of influence—particularly since reports indicate a selling price for the Tu-104A of a little more than half of that quoted for the Comet.

It is significant also that the U.S.S.R. has confined its jet designs so far to the medium ranges and has concentrated on turboprops for short and long ranges. Being an eminently practical people, the Russians probably feel that, over very long ranges, turbojets

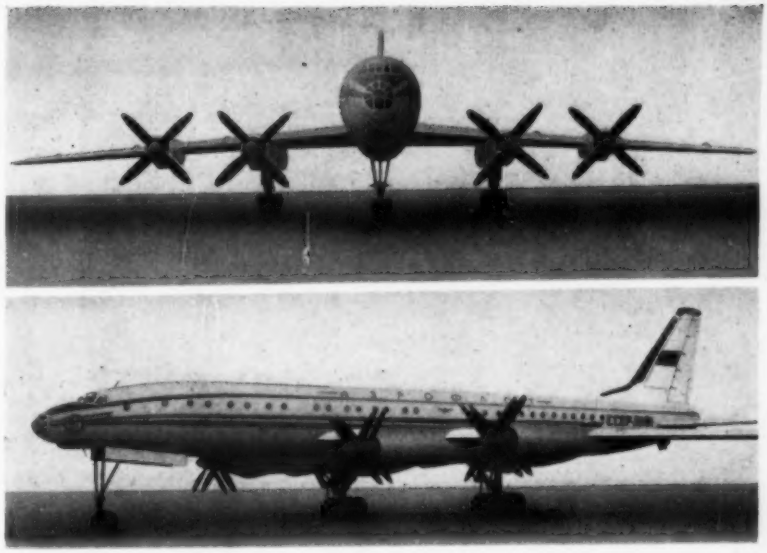
** Some of them might be filled in with already-published data of varying degrees of reliability. Not all of the figures given by our contributor, incidentally, agree with those published in recent months.—Ed.*

TABLE 1—TURBOJETS

	Boeing 707	de Havilland Comet 4B	Convair 880	Tupolev Tu-104 (and A)	Tupolev Tu-110
Engine type	RCo.10	R.A.29	G.E. CJ-805	Mikulin	Lyulka
Take-off thrust (lb)	4×16,500	4×10,500	4×11,200	2×15–19,000	4× —
Maximum a.u.w. (lb)	296,000	152,500	178,500	121-156,000	—
A.u.w. less fuel and payload (lb)	128,000	75,000	85,000	—	—
Capacity payload (lb)	38,000	22,000	23,000	16–22,000	31,000
Capacity fuel (lb)	153,000	63,000	70,000	60–62,000	—
Equivalent still-air range (n.m.)	5,100	3,900	3,500	3,500	—
Cruising speed (kt)	478	439	500	435–500	—
Wing area (sq ft)	2,908	2,121	2,000	2,024	—
Aspect ratio	6.98	6.22	7	6.5	—
Thickness ratio (per cent)	9	—	—	12	—
Sweep angle (deg)	35	25	35	40	—
Length (ft)	138.90	111.50	124.10	121.5	125.50
Span (ft)	142.4	115.00	118.30	114.9	122.90
Field length (ft)	9,600	6,600	7,200	5,100–6,900	—
Wing load (lb/sq ft)	101.80	71.80	89.30	60–77	—
Thrust load (lb/lb)	4.48	3.63	3.98	4.1	—

TABLE 2—TURBOPROPS

	Bristol Britannia	Vickers Vanguard	Lockheed Electra	Antonov Ukraina	Ilyushin Moscow	Tupolev Tu-114
Engine type	Proteus 755	Tyne 1	Allison 501	Kuznetzov	Kuznetzov	—
Take-off power (e.h.p.)	4×4,150	4×4,795	4×3,750	4×4,000	4×4,000	4×12,000
Max. a.u.w. (lb)	175,000	141,000	113,000	112–120,000	120–130,000	—
A.u.w. (F + P) (lb)	88,000	79,000	61,000	—	—	—
Capacity payload (lb)	28,000	25,000	23,000	26–29,000	31,000	46,000
Capacity fuel (lb)	69,000	40,000	35,000	—	—	—
E.S.A. range (n.m.)	5,000	2,800	2,500	2,700	2,700	6,500
Cruise speed (kt)	340	365	350	300–340	350–360	435–500
Wing area (sq ft)	2,075	1,529	1,300	—	—	—
Aspect ratio	9.45	9.20	7.50	—	—	—
Thickness ratio (per cent)	17–9	15–13	—	—	—	—
Sweep (deg)	0	0	0	0	0	25
Length (ft)	124.25	122.90	104.50	119	—	138
Span (ft)	142.30	118.60	99.00	140	123	190
Field length (ft)	7,500	6,600	6,000	2,500	—	—
Wing load (lb/sq ft)	84.30	92.20	86.80	—	—	—
Power load (lb/e.h.p.)	10.60	7.36	7.53	—	—	—



Two new views of the Tu-114 prototype. Note that the inboard nacelles and propellers are well clear of the fuselage. The nacelles themselves appear to be similar to those of the "Bear" bomber.

are too expensive to operate; over very short ranges the speed differential means nothing and that the only range bracket in which the turbojet is worthwhile is for stages between about 1,000 and 2,000 nautical miles, where the cost differential is at a minimum.

In Table 2 I have again written down the facts as I know them. It is immediately apparent that the Ukraina and Moscow have been designed to requirements very similar to those for the Electra and Vanguard. The only really noticeable difference is that the Russian designs have been optimised to shorter ranges and hence carry a bit more payload. In addition, they seem to be aimed at operations from considerably shorter runways.

Of the two, the Moscow is slightly the cleaner design, but is a bit heavier and probably uses more field length. The Ukraina particularly appeals to me because I like high wings, low tailplanes, low floors and fuselage-mounted undercarriages.

Here again, if they have managed to build a reliable aeroplane, the Russians have little to fear in competition from the Vanguard or Electra within their own orbit of political influence. [According to Aeroflot last week, the Moscow will be in service next year.—Ed.]

The Tupolev Tu-114 is a different kettle of fish altogether. Considerably bigger than the Britannia and having engines which are half as powerful again as the Orion would be if it were ungated, this is a formidable aeroplane and one which is very much like the sort of thing we should have been building now.

For years it has been apparent that the big turboprop is the cheapest and most flexible form of long-range transport which we know how to build and that it is going to remain so for a long time. We have the engines but lack the money (or initiative) to build the aircraft. The U.S.A. would love to build it but haven't the engines; and now the U.S.S.R. has stolen a march on both of us.

I can only guess at a lot of the parameters of the Tu-114, but the wing seems to have about 25 deg of sweep and a moderate thickness—probably 12 per cent, if current Tupolev jet practice is anything to go by. This means an ability to cruise clear of any drag rise at about M=0.75 or 0.8.

It does not look like a 0.85 aeroplane such as the Boeing 707 or Douglas DC-8, and I would expect a true cruising speed of about 450 kt. The propeller tips must be doing about M=1.1 or at least M=1, and why not? Current knowledge would give them a propulsive efficiency, in front of a good nacelle, of about 79 per cent. What I would dearly like to know is how they have damped the structure in way of the noise emanations. Noise on the airport would not, of course, be a problem, because the propeller tips would never get near M=1.

Rumour has it that the four turboprops are of 12,000 h.p. If they are orthodox ungated engines, then the total thrust available at 36,000ft and M=0.75 should be about 13,500 lb. At a cruising L/D of 18 (not unreasonable) the mean weight is 243,000 lb.

If the engine specific consumption is as good as that associated with modern British practice, then the fuel load for a 6,500 n.m. E.S.A. range should be about 45 per cent. If this is so, then the maximum take-off weight of the Tu-114 is over 300,000 lb.

In the Tu-114 the U.S.S.R. has an aeroplane with a payload capacity at least as great as (and probably more than) that of the Boeing 707; a comparable a.u.w.; 40ft more wing span; and a range capability at least 40 per cent greater at 40 kt less speed. Direct operating costs are almost certainly lower over a much wider range of stage distances than the big U.S. jets, and field length requirements are probably 30 per cent less at least.

All I can say about this very fine aeroplane is that I wish we had built it! The one thing I would like to ask Mr. Tupolev is why he changed from the high wing layout on the Bear to a low wing on the Russia. I should have thought that the Ukraina configuration scaled up to Tu-114 size would have been ideal.

I think we can conclude that in the face of the new Russian aeroplanes, the West is going to find it very difficult to sell aeroplanes in any of the "politically uncommitted" countries.

ALCOCK AND BROWN EXHIBITION

NOW on show in the exhibition hall of Queen's Building at London Airport Central is a collection of mementos associated with the first non-stop crossing of the Atlantic by air—the historic flight by Captain John Alcock and Lt. Arthur Whitten Brown in a Vickers Vimy bomber in June 1919. The exhibition, which has been sponsored by Vickers-Armstrongs (Aircraft), Ltd., in conjunction with the M.T.C.A., contains much that is of interest to the aviation enthusiast. In addition to photographs of the flight, there are the actual compass, sextant and chart used by navigator Whitten Brown on the flight, together with his flying clothing; Alcock's passport; Twinkletoes, his cat mascot; menus of commemorative functions and a reproduction of the *New York Times* front page reporting the event. Most fascinating items, however, are undoubtedly the photostat copies of pages from the flight log and of notes passed between the two men during the flight. The first page of the log records: "Wind strong and gusty. Heavy bumps taking off and climbing. Took off at 4.12. Low clouds." Included in the in-flight notes are:—

"This is a great trip—no ships or stars or anything. Have a sandwich?

"Would be better lower down where the air is warmer and we might pick up a steamer.

"Immediately you see sun rising point machine straight for it and will get its compass bearing.

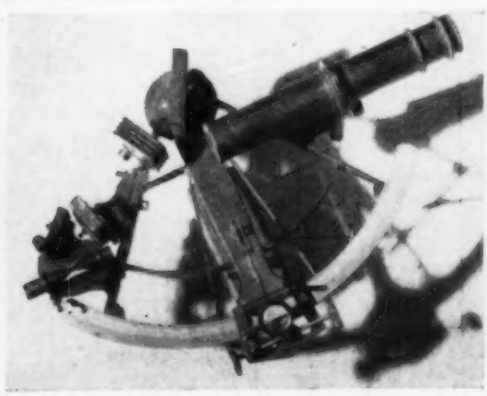
"I cant get any obs in this fog—will estimate that same wind holds and work on D.R.

"Lets try and spot a rly stn first—crossed land at 8.25 on 15th, civil time.

"Probably N. Ireland—can you carry on and go farther S. Follow the rly—landed at 8.40 g.m.t."

The last page of the log reads: "In sight of land. Crossed coast at 8.25 a.m. civil time. Identified Clifden wireless, and landed at 8.40 a.m. Coast to coast 15 hr 57 min, flying time 16 hr 28 min."

The London Airport exhibition is expected to remain open until the end of this year, after which it is hoped to present it at a number of cities.



Brown's liquid-damped bowl compass (left) and marine-type sextant, which has been loaned by the Royal Aero Club.

HERE AND THERE

Speed Record Attempt

IT was announced in Washington last week that a U.S.A.F. McDonnell Voodoo would make an attempt on the world speed record of 1,132 m.p.h. set up by Peter Twiss in March last year in the Fairey F.D.2.

D.H. Holdings Appointment

AT a meeting on November 19 of the Board of de Havilland Holdings, Ltd., the parent de Havilland company, Mr. A. F. Burke was appointed deputy chairman. He is also chairman of the D.H. Engine Co., Ltd., and managing director of the D.H. Aircraft Co., Ltd.

Australian Missile Range

A NEW launching area for testing British missiles is being constructed in Australia about 30 miles west of the present Woomera range. About £9m sterling may be spent during the present financial year on this new development.

THE WORLD'S MISSILES

EVERY worthwhile publishable fact about guided weapons, British and foreign, will be found in *Flight* next week (December 6), a greatly enlarged special number. In addition to this profusely illustrated review of modern missiles, feature articles will deal with the part played by rockets in current space-exploration experiments, with the intercontinental ballistic missile, and—in a more technical vein—with design parameters of air-to-surface weapons. Regular aviation news features will also appear in this issue, on sale (the demand is certain to be heavy) at the usual price of 1s 6d.

Historic Vimy Damaged

THE Vickers Vimy bomber flown by Capt. Ross Smith and Lt. Keith Smith in the first flight from Britain to Australia in November-December 1919 was severely damaged by fire recently, while being transported by road from Canberra to Adelaide. The aircraft was to have been housed in a special memorial hangar near the main terminal building at Adelaide Airport. Another Vimy, that flown by Alcock and Brown in the first non-stop transatlantic flight, is the subject of a current exhibition at London Airport (see p. 829).

Blown Flaps for F-104

FLAP blowing is to be applied to the Lockheed F-104, reducing landing speed by 20 m.p.h. and landing run by 25 per cent. Air is to be blown over the flap at 2,300ft/sec from over 100 slots, 0.9in apart.

Scottish Pioneer

A SCOTTISH air pioneer, Mr. James Y. Watson, who, with his brother Preston, began experimental construction of aeroplanes at Errol in Perthshire in 1903, has died at Blairgowrie at the age of 78. Until two years ago he invariably took up a flying-club aircraft on his birthday.

Short Transfers

AN announcement by Short Brothers and Harland, Ltd., last week said that in order to cut overhead costs all work now being handled by the company's factories at Lisburn and Ballyclare (Antrim) would be transferred to the main aircraft works at Queen's Island, Belfast, during the next few months. Overall redundancies up to the end of March would not be more than 220.

Sycamore Deliveries

THREE more Bristol Sycamores—the eleventh, twelfth and thirteenth of the 50 machines ordered by the Federal German Government—left Weston-super-Mare last week on their delivery flights to training bases at Memmingen and Fassberg. Two of the aircraft were flown by German pilots who have just completed the Sycamore conversion course and the third by Bristol helicopter test pilot Bob Smith.

Cossor Radar Tour Ends

IN a recently completed European tour extending over six thousand miles the Cossor radar type CR 21 has been demonstrated at fourteen centres in nine countries to more than five hundred senior military and civil aviation officials. The company states that the average time required for three men to erect the scanner and set up the equipment for demonstration was three and a half hours.

P.S. to Powered Controls

FROM Lt. R. B. Mancus, R.N. (Retd.), of Boulton Paul Aircraft, Ltd., comes a comment on the article "Control Systems Outlook" published in our issue of November 15. Referring to the statement that an electrical system utilizing Boulton Paul flying controls and limited to the aileron channel had been flown in the U.K. in the Tay-

"FLIGHT" AT FONTAINEBLEAU: Before taking leave of Air Chief Marshal Sir George H. Mills, R.A.F., Commander, Allied Air Forces Central Europe, Lt-Col. Horst Krueger of the German Air Force draws Sir George's attention to the general arrangement drawing of the Marcel Dassault Etendard VI in "Flight" of November 8. Col. Krueger is now posted to the flying school at Fuerstenfeldbruck.

Viscount, Lt. Mancus remarks: "I flew this machine for the first time last May and can assure you that it is fully electric on all control surfaces. Satisfactory flight trials are continuing on this project."

Cirrus Bombardier Overhauls

OVERHAUL life for the Blackburn Cirrus Bombardier 208 piston engine has been upgraded by Air Ministry to 600 hr. Last year the Ministry increased the period between overhauls to 500 hr following an examination of engines stripped down after completing 400 hr in an operational theatre.

Palmer Aero Products

FROM December 2 the Palmer Tyre, Ltd., a member of the B.T.R. group of companies, is to be known as Palmer Aero Products, Ltd. Mr. C. G. Erlam becomes general manager and will also be in charge of the group's aero division.

December—

AT the December Forum of the Aircraft Recognition Society, to be held on December 11 in the library of the Royal Aeronautical Society at 4 Hamilton Place, London, W.1., the panel of experts under the chairmanship of Mr. Colston Shepherd will include Sir Arnold Hall (Hawker Siddeley director) and Mr. Peter Twiss.

—Forums

THREE well-known test pilots, W. R. Gellatly (Fairey), H. G. Hazelden (Handley Page) and Ranald Porteous (Auster), are taking part in a "test pilots' forum" being held by the London branch of Air-Britain next Wednesday (December 4) at Caxton Hall, S.W.1, at 7 p.m.

Sonic Boom Damage

IN a Parliamentary answer on damage caused by supersonic bangs the Air Minister, Mr. George Ward, said last week that 1,439 claims had been investigated during the past three years and the effect of such sounds on buildings was being studied by the Building Research Station of the D.S.I.R. No damage to the main structure of buildings had as yet been observed.

"T.V." RECORDING: Shock-waves pile up ahead of a Chance Vought Regulus I missile as it dives at terminal velocity. Angle of the waves indicates a Mach number of about 1.1.

British Air Safety Standards

Stricter Rules for the Older Transports

Typifying the older generation of transports which will be affected by new British airworthiness standards is the DC-3. About 100 are on the U.K. register, half of these being owned by the independent airlines.

OF special concern just now are the steps which the Government have for a long time proposed to take in order to raise the airworthiness standards of the older transport aeroplanes still operating on the British register. The new requirements, which may cause economic hardship —particularly to some of the independent airlines—are likely to come into force in little more than a year.

MEASURES which may substantially impair the economical operation of the older transport aircraft used by British operators have, *Flight* understands, now reached an advanced stage. The Ministry of Transport and Civil Aviation have notified the British air transport industry of the proposed changes which will be made to tighten up the airworthiness standards of aeroplanes such as the DC-3, Viking, Freighter, York, Solent, Hermes and so on. These involve (1) the introduction of weight, altitude and temperature (WAT) limitations for the DC-3, Viking and Freighter 21, and (2) amendment of the Air Navigation Regulations under which these and the other older transports at present operate. The provisional date fixed for these changes to become law is January 1, 1959. Obviously, the operators most affected by these changes will be the British independent airlines.

The aircraft concerned* fall into the "unclassified" performance group of the British Civil Airworthiness Regulations: were they to be operated to these regulations their use would of course be severely limited. As matters stand at present, the requirements to which these aircraft are in fact operated, particularly those requirements affecting engine-out take-off performance, do not ensure a level of safety which comes within the accepted present-day definition of the term airworthiness.

This does not mean that these older types are to be condemned as dangerous: it is recognized that for 12 post-war years some 200 of them have achieved a good record of safety and service. But it does mean that the law intends to secure a more uniform level of public air transport safety, and more effective *control* of that safety.

The proposed airworthiness amendments have not been sprung as a surprise upon the airlines. The Government made known its intended policy three or four years ago, and circulated its preliminary proposals for comment two years ago. These were arrived at with the co-operation and guidance of the Air Registration Board, but not without considerable difficulty. This was mainly due to the lack of scheduled performance information about the aircraft concerned, which were designed, tested and brought into service in an era of unsophisticated airworthiness standards. But it is significant that all but one or two operators accepted the basic technical common sense of the proposals. The objections which were raised against the proposed amendments (and there were many) were directed mainly at their adverse commercial and economic effects.

What is the likely effect of the new requirements on the economy of the industry? The requirements themselves may be briefly summarized as follows:—

(1) The introduction of full temperature accountability for take-off.
(2) The introduction of one-engine-out flight-path obstacle clearance.
(3) The introduction of a two-engine-out requirement on long over-water flights.
(4) Strengthening of the existing one-engine-out *en route* requirement to maintain minimum safe altitude while conducting a flight to a suitable aerodrome, and also to maintain an altitude of 1,500ft above that aerodrome. The aeroplane would also have to meet landing distance requirements on this aerodrome.
(5) Strengthening of landing distance requirements by deleting the provision for visual approach and landing.
(6) The introduction of a limitation in the weather conditions in which an aeroplane which is unable to maintain altitude with one-engine-out can operate.
(7) Introduction of a requirement not to fly below the altitude calculated as being necessary for compliance with the one-engine-out requirements.
(8) Aircraft of U.S. manufacture to be operated to a code based on Part 40 of the American C.A.R.s, except for (a) the revision of the take-off flight-path obstacle-clearance requirement by one calling for an increasing obstacle clearance with distance, and temperature accountability, and (b) the replacement of the two-engine-out *en route* climb requirement by a requirement calling for the ability to reach an aerodrome similar to that proposed for unclassified British aircraft.

After comments had been received on these proposals, they were revised in the following manner:—

(1) The one-engine-out obstacle-clearance at take-off to be a constant 35ft instead of increasing with distance.
(2) The criterion for the application of two-engine-out performance requirements to be "90 minutes from shore," and the landing distance requirements need not be met at the emergency aerodrome.
(3) "Terrain clearance" prescribed for the engine-out *en route* case.
(4) The requirement taking runway slope into account deleted.
(5) The limiting weather minima of low-stalling-speed aeroplanes unable to achieve a one-engine-out climb gradient of ½ per cent at 2,500ft above mean sea level reduced to a 1,000ft cloud ceiling and one-mile visibility at the terminal and the alternative.
(6) The requirements for aeroplanes with American flight manuals to correspond in all respects to C.A.B. rules except for the two-engine-out *en route* case and take-off obstacle clearance case.

* * *

The commercial effect of these requirements is not easily summarized, since operators employ the old aircraft concerned in such varying conditions. But, as a generalization, it may be said that in Northern Europe, limitations of weight by altitude and temperature will put a small economic penalty on the DC-3 and, to a lesser degree, on the Viking, but will seriously affect the early Mk 21 Freighters (though not so much the later 31s and 32s). In warmer climates, however, and particularly in Africa, WAT limitations will be substantial.

The two-engine-out *en route* requirement will of course rule out DC-3s and Vikings from long ("90 minutes from shore") over-water flights, though few such British services are flown with these types. This requirement may restrict Yorks considerably, and

(*continued on page 852*)

**Anson, Argonaut, Chipmunk, Consul, DC-3, Dove, Freighter 21 and 32, Gemini, Hermes 4 and 4A, President, Prince 3 and 4, Rapide, DC-4, Solent 2, 3 and 4, Tudor 2, 4 and 5, Viking, York.*

Two ways in which the economical penalties of the proposed new regulations might be reduced are by a modification to the power section of the Bristol Hercules 600, powerplant of the Viking, Freighter 21, Solent 3, etc. (a Viking engine is shown in the picture); and by incorporating on DC-3s the undercarriage fairing designed by the independent airline Transair, Ltd.

c

THE AERONAUTICAL BOOKSHELF

"Brassey's Annual, The Armed Forces Year Book, 1957," edited by Rear-Admiral H. G. Thursfield; assistant editors, Brig. C. N. Barclay and A.V-M. W. M. Yool. William Clowes and Sons, Ltd., Little New Street, London, E.C.4. Illustrated. Price 63s.

THE year covered by this latest edition of *Brassey's Annual* has, from the military and political viewpoints, been momentous. The two major events—the Anglo-French action at Suez and the final emergence of Russia as a competent and advanced aeronautical nation—are both dealt with in this edition.

Asher Lee has contributed a striking chapter on the operational strength of the Russian and satellite air forces and gives, too, an insight into some of the technical achievements of Soviet aviation. Essential details about Russian aircraft are notoriously difficult to find, but this summary is one of the most honest appraisals made recently on this difficult subject. It is marred only by a case of mistaken identity in a picture showing the tail gun-turret of an Ilyushin Il-28 which is described as a Russian four-jet bomber, implying that it is the much more elusive Bison. Guided weapons have been reported upon by the technical editor of *Flight*. Here again some important facts remain unobtainable, but great trouble has been taken to achieve accuracy, and it is quite clear that the author's wide knowledge has enabled him to ignore all the inconsequential and sometimes misleading information which has been put about by some governments and manufacturers.

Other authors—E. Colston Shepherd, D. M. Desoutter and (though not entirely concerned with aviation) the late Jules Menken—show that *Brassey's* has again chosen informed contributors. It is a reliable bedside book for any private, squadron leader or admiral of the fleet. A.C.B.

"Cloud Study. A Pictorial Guide." By F. H. Ludlam and R. S. Scorer. John Murray, 50 Albemarle Street, London, W.1. Illustrated. Price 12s 6d.

STUDY of the weather has for years been bedevilled by complicated books directed at, but largely incomprehensible to, the ordinary interested person. The apparent purpose of many of them has been to present the weather as a neat academic subject for edification during the long winter evenings. rather than as a part of everyday life.

Fifteen years ago this reviewer produced a book, *Cloud Reading for Pilots*, intended for the person who wanted to learn by looking at the real thing, and it presumably filled some need, because it is still selling. *Cloud Study* is a further, and excellent, effort in the same direction.

The authors of this book are scientists who have learned how to present their practical knowledge so that it is both interesting and readily understandable. The meat is divided into small sections, so that breath can be drawn while the latest fact is assimilated. After the initial informative opening, the book continues with some really excellent photographs of skies which are clearly analysed, both as regards what had occurred to produce the clouds, and what is likely to develop from the formation. Some of these pictures are in colour, and there are helpful diagrams.

A minor criticism, however, might be offered. It arises from the fact that the authors' international outlook on met. is not yet shared by the majority of their readers. All their measurements are metric system; with this one is in wholehearted agreement, but there is no conversion table for those poor individuals who do not yet think in these units. A.W.

"Ark Royal 1939-1941," by Sir William Jameson. Rupert Hart-Davis, Ltd., 36 Soho Square, London, W.1. Illustrated. Price 30s.

LAST September Herr Carl Francke was seeing for himself at the S.B.A.C. Display how far our aircraft have progressed since he met them during the war. Probably, he reflected how much more businesslike were the Sea Vixen and the Scimitar than were the Skuas for which he kept a wary eye the day he "sank" *Ark Royal*. But according to this book Francke committed suicide 16 years ago because "the honours and publicity which came his way for a deed he had never done, and the gibes of his brother officers when the truth was finally established, so preyed upon his mind. . . ."

The book is described as a "detailed and authoritative history." But Francke is alive today and taking an active interest in the new German aviation. Sir William Jameson himself does not claim that the book is "authoritative"—it is the publisher's note that says so. And that is the point of this criticism: publishers should not run any risk of misleading readers.

The work as a whole is a valuable record of the short but active life of H.M.S. *Ark Royal* the third. The considerable contribution which aircraft carriers made in the early part of the war is not well known, because it was overshadowed later on by the great air-sea battles in the Pacific. The carriers were not incidental in the earlier naval campaigns, although their effectiveness would have been much more had their aircraft been more comparable with those of the R.A.F. *Ark's* Skuas could match neither the speed nor the ceiling of the Heinkel 111 against which they were so often sent. The Swordfish torpedo bombers scarcely had a sporting chance against Me109s and Me110s—although the old Stringbags often got away, not unscathed, but still flying. A.C.B.

"The Gee Bee Story," by Charles G. Mandrake. Published by Robert R. Longo, Wichita, Kansas, and obtainable from W. E. Hersant, Ltd., 228 Archway Road, London, N.6. Illustrated. Price 17s 6d (plus 8d postage).

AVIATION enthusiasts in Britain had only one opportunity to see a Gee Bee racer; but few of those who were at Mildenhall aerodrome back in 1934, when the dumpy QED monoplane arrived just 36 hours before the start of the MacRobertson Race, are likely to forget it.

In this book Charles Mandrake recalls that "The double-hinged flaps caused disruption of air flow over the ailerons and caused the wing to begin to stall as well; so as it came in for a landing the QED would often drop the last 25 or 50 feet with a resounding bang. It was just getting dark when the ship arrived at Mildenhall and it made just that kind of landing." It did indeed!

The Gee Bees had many other little idiosyncrasies which brought most of them to a sticky end. But in the hands of master pilots like Jimmy Doolittle they achieved wonders in America's National Air Races, and the R-1 even set up a landplane speed record of 296.287 m.p.h. on only 800 h.p.

For that reason, and because they have never been excelled in colourful attraction for model-makers, they are assured of a place in aviation history, and this biography of the Gee Bees should prove as popular here as in the States. Apart from rather primitive spelling in places, it is quite comprehensive and is illustrated with a large number of first-class photographs, many hitherto unpublished. There are even references to the tail-first Ascender, a little-known Gee Bee with Aeronca parentage. J.W.R.T.

CHRISTMAS LIBRARY

IT is now less than a month until Christmas, and shoppers for presents are certain to find that it will be a very short month indeed. Books are almost always acceptable gifts for people of all ages, and among those published by the house of Iliffe are books certain to appeal to those interested in a wide variety of subjects outside the fiction sphere.

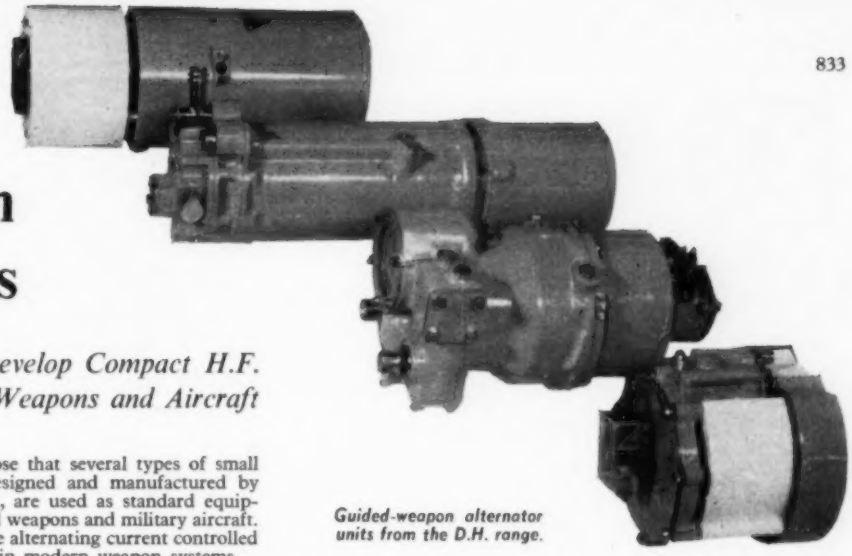
To begin with books associated with *Flight*, the following may be mentioned (price by post is given in parentheses after the published price): *Boy's Book of Flight*, by David Le Roi, 12s 6d (13s 6d); *Development of the Guided Missile*, by Kenneth W. Gatland, 15s (16s 2d); *Gas Turbines and Jet Propulsion*, by G. Geoffrey Smith, revised by F. C. Sheffield, 35s (36s 9d); *Flight Handbook*, 15s (16s 3d); *Flight Flypast* (pictorial), 7s 6d (8s 6d); *Fellowship of the Air*, by B. J. Hurren, 30s (31s 9d).

In association with other Iliffe journals many more books are published, and among them may be cited *Car Driving as an Art*, by S. C. H. Davis, 12s 6d (13s 6d); *Value-for-Money Motoring*, by J. R. Davey, 7s 6d (8s 2d); *Methods of the Experts* (for motorists), 2s 6d (3s); *Brighter Photography for Beginners*, 6s (6s 8d); *Photograms of the Year* (pictorial), 18s 6d (20s 3d); *The Complete Amateur Photographer*, 21s (22s 4d); *Correcting Television Picture Faults*, 3s 6d (4s); *Improve your Television Reception*, 5s (5s 6d); and the *Yachting World Annual 1958*, 35s (36s 9d).

In addition, a number of our journals publish pocket diaries relevant to the fields which they cover, including motoring, motor cycling, yachting, photography, radio and nursing. Full details of these, and of the books named above, are obtainable on application to Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1.

Power Generation in Missiles

D.H. Propellers, Ltd., Develop Compact H.F. Alternators for Guided Weapons and Aircraft



Guided-weapon alternator units from the D.H. range.

IT is now permissible to disclose that several types of small high-frequency alternators designed and manufactured by de Havilland Propellers, Ltd., are used as standard equipment in a number of British guided weapons and military aircraft. These compact power units provide alternating current controlled to the close tolerances demanded in modern weapon systems.

De Havilland entered this specialized field with a firm background of experience of hydraulic, electronic, and precision engineering gained in the manufacture of propellers. The first project to be undertaken was the design of a cordite-driven turbo-alternator on which studies had already been carried out by the Ministry of Supply. It was developed especially for an early guided weapon, but the subsequent rapid expansion of the missile industry in Great Britain brought the demand for the wide range of power units now in production.

De Havilland power units consist of two main sections. These are the alternator assembly—comprising an alternator, a pack of resonating condensers and a controlled drive—and the controller.

The Alternator Assembly. Inductor alternators are used in all de Havilland power units. Several factors influenced the choice of this type of alternator. The requirement for the first power unit to be driven directly by a turbine determined that alternator rotational speeds should be in excess of 20,000 r.p.m. An output frequency of more than 2,000 c/s was clearly necessary in order to keep the powered components to a minimum size. Use of the simple, robust inductor alternator, which contains no slip-rings or rotating windings, provides the obvious solution. At a speed of 24,000 r.p.m. an inductor alternator containing a six-pole rotor produces a frequency of 2,400 c/s, and a salient two-pole permanent-magnet rotor can be mounted in tandem to produce a standard 400 c/s frequency.

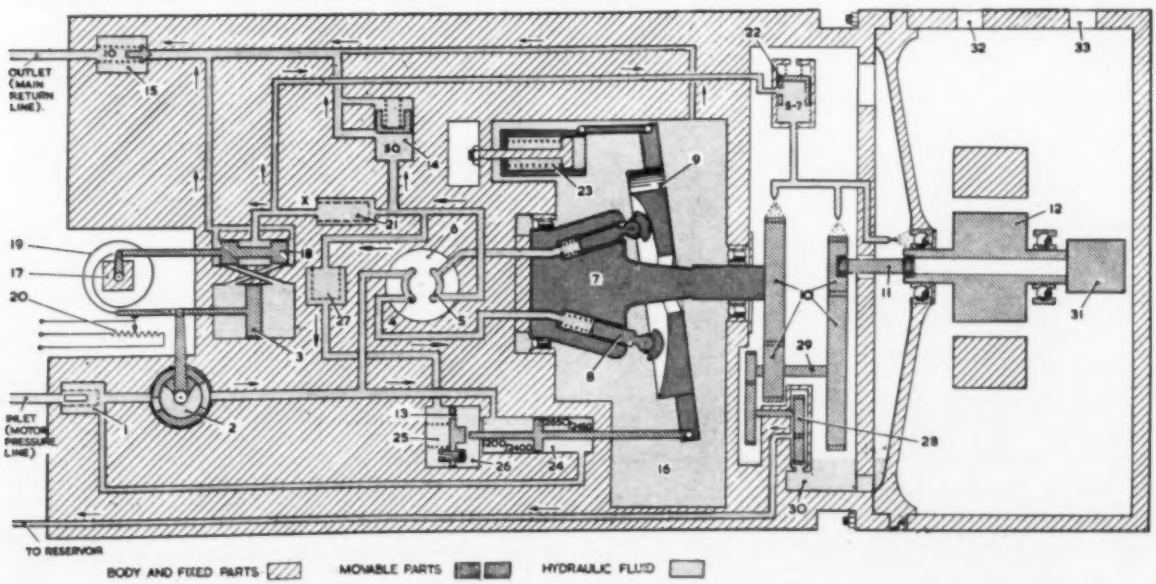
The static part of the alternator consists of two stacks of C-shaped soft-iron laminations butting together and shaped to form a circular yoke with four integral poles. Four coils, two field and two output, are wound alternately round the yoke, one coil between each pair of poles. The stacks and rotor bearings are carried in a suitably shaped container with the necessary provision for mounting. Certain later types of alternator have single-piece stator lamination with coils wound round the poles.

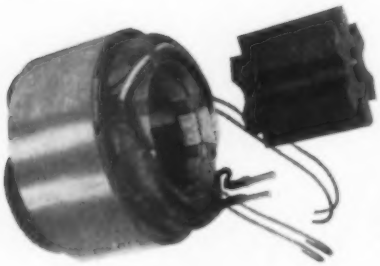
Inductor alternators are not in themselves self-excited, but are self-maintained when sufficient power is generated. This demands either that permanent magnets must be fitted in the field circuit or that a separate initial field supply is used. Voltage is maintained within the required limits by controlling the field current from a voltage-regulator circuit.

An inductor alternator, although permitting simple mechanical construction, has certain disadvantages. Its high internal impedance, which is particularly emphasized in a small machine, necessitates the use of resonating condensers in series with the load. These condensers are also used to overcome unacceptable variations of waveform which could otherwise result from certain types of load.

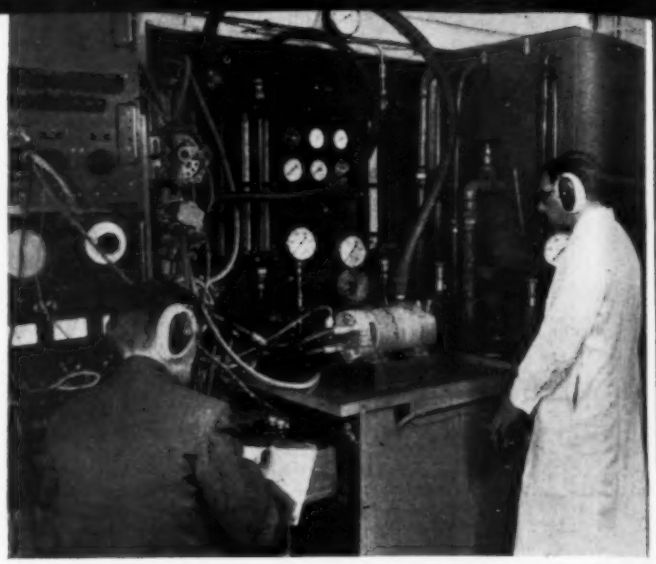
The alternator is driven either by a gas turbine or an oil motor. The turbine runs with equal success on high-pressure air, cordite gas, high-test peroxide, or burning iso-propyl-nitrate. Oil drive is achieved by a conventional gear motor, linked to the alternator through a drive gearbox. The sensitive speed control

Circuit diagram of typical power unit for use in aircraft: 1, Inlet filter; 2, Throttle valve; 3, Servo piston; 4, Motor inlet port; 5, Motor exhaust port; 6, Port insert; 7, Motor rotor; 8, Plunger; 9, Swashplate; 10, Gears; 11, Quill shaft; 12, Alternator rotor; 13, Restrictor; 14, Pressure-maintaining valve; 15, Non-return valve; 16, Motor chamber; 17, Transducer; 18, Selector valve; 19, Spring; 20, F/B potentiometer; 21, Servo filter; 22, Pressure-reducing valve; 23, Control-spring cylinder; 24, Swashplate actuator; 25, Dashpot; 26, Non-return valve; 27, Dashpot filter; 28, Scavenge pump; 29, Gear layshaft; 30, Oil sump; 31, Centrifugal switch; 32, Cooling air inlet; 33, Cooling air exhaust. Fluid pressures at certain points in the hydraulic circuit are indicated by small figures.





(Left) A rotor pack and stator assembly from a hydraulically driven alternator.



(Right) One of the new power units on bench test.

POWER GENERATION IN MISSILES . . .

necessary for both gas- and oil-driven alternators is achieved by the use of a proportional relay, or transducer. This comprises two permanent magnets with their north and south poles coupled by wound cores, which surround a soft-iron armature. Each core has two windings, which, when fed with current, can affect the armature position. If the currents in the windings are equal the armature remains in a central position, but if the currents vary the armature turns accordingly. A drive is taken from the armature pivot, sufficient torque being developed either to operate a throttle directly or through a closed-loop mechanical servo. This mechanism, a Laws relay, is now used extensively by the weapons industry.

The type of throttle varies according to application. A simple rotary valve operated directly by the relay proves efficient for a clean, cool gas supply, whereas with hot gas or extremes of temperature a servo-operated tapered needle is needed. Servo assistance is also necessary for the hydraulic throttles, of which various types have been tried. The most effective has proved to be a "hole and hill" type, which is a rotary valve with two inclined planes cut into its top surface. These planes mate with ports in the sleeve so that rotary motion of the valve varies the area of port uncovered. This system has proved remarkably sensitive.

A mechanical feedback is always provided to close the mechanical servo loop, generally by a spring which couples the transducer armature to the throttle, although later designs accomplish this action by a direct linkage mechanism. Mechanical systems such as these have a delay which, when included in the complete frequency-control loop, tends to produce instability. To counteract this, the throttle is made to operate an electrical feedback circuit by moving a wiper arm over a potentiometer.

The Controller is divided into two sections, the voltage regulator and the frequency governing circuit. In the voltage regulator, the alternator output is fed into the primary winding of a transformer. The resultant output of the secondary winding is rectified and fed, through a choke, to a neon bridge circuit. This is adjusted so that at a given load (approximately mid-range) the control current is fed either to a single or a multi-stage magnetic amplifier, which produces the level of field current required to give the nominal output voltage. Variations in this output voltage, due to load changes, then cause changes of error current which in turn alter the field current through the magnetic amplifier, so that the initial output voltage variation is reduced.

The frequency governor controls the operation of the transducer. As in the voltage regulator, the alternator output is fed into a transformer and then into two resonant circuits, one tuned above the required datum and one below. These circuits are each connected in series with a bridge rectifier so that at the nominal frequency the output from each rectifier is the same. As the tuned circuits are set one above and one below the datum frequency, the output from one increases as the other decreases with an off-speed. The difference in these outputs is then applied through a push-pull magnetic amplifier to the transducer coils. This in turn reacts on the transducer armature, the resulting rotation being in the correct direction to reduce the initial frequency deviation.

Aircraft Power Units. Once the merit of the early work on alternators for guided weapons had been established, it was a logical step for de Havilland Propellers to design a range of associated power units for use in aircraft. The unit in this case is of similar basic design to the weapon alternator, but is driven by fluid from the aircraft hydraulic system. It is built to a rigid mechanical specification to achieve continuous rating. The high power output demands the use of a swash-plate motor rather than a gear motor, and thus two stages of throttling are possible. Fine control is achieved by using a rotary valve, while coarse control for large load-changes is obtained by altering the angle of the swashplate and thus reducing the motor capacity. In this way the considerable amount of heat generated in the oil by a single throttle is obviated, with consequent simplification of the aircraft oil-cooling system. The actuator for the swashplate consists of a damped piston which measures the pressure-drop across the throttle. If this drop becomes excessive, the piston moves in its housing and, by a simple linkage, alters the angle of the swashplate.

As the motor speed is lower than that of the alternator rotor a gearbox is necessary. For continuous rating, lubrication is essential and an oil tapping is taken off the motor return line. Oil pressure is maintained at a suitable level by a small valve, and is fed through lubricating jets to a two-stage spur-gear train. Excess oil is scavenged by a small gear pump and returned to the aircraft hydraulic system. A simple lip seal prevents oil from reaching the alternator. Later developments include a self-contained lubrication system which consists of a small tank with feed and scavenge pumps driven off the gearbox layshaft.

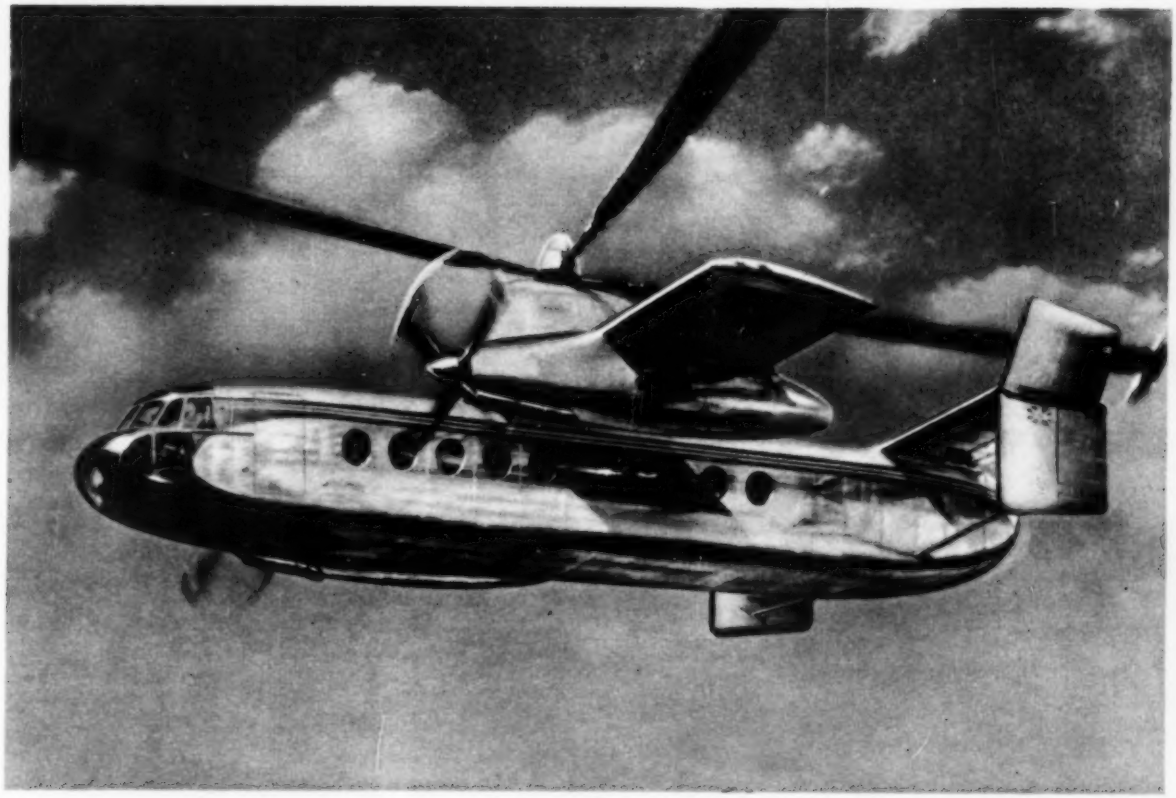
The relatively heavy rotor shaft is carried on angular contact bearings held together by a spring-loaded piston. Attached to the rotor shaft is a small centrifugal actuator which consists of a hollow piston spring-loaded against two small flyweights. At a given shaft speed (below nominal) the piston slides out and operates a micro-switch. This switch allows the protective circuits built into the control unit to become operative and to cut off the hydraulic supply *via* the on-off valve if the unit should subsequently overspeed or underspeed violently. As a protection against run-up to a speed less than the switch setting, a time delay is fitted which causes the switch operation to be overridden in a finite period and the oil supply to be cut off. It is essential that the alternator coil temperatures do not rise to a value which would impair their operation. The techniques employed in their construction give ample scope for cooling to be effected by ram air, despite the high aircraft speeds, and experience has proved that cooling for the controller and condensers is unnecessary for most applications. Where essential, however, provision may be made for a small flow from a cold air unit.

The high power developed by the unit demands large condensers. For convenience of installation, these condensers are fitted into a separate case, the bulkhead of which acts as a junction box for the three components which comprise the power unit. A filter is incorporated in this case to improve the output waveform when running into distorted loads.

Three circuits within one case constitute the controller. These are the voltage regulator and frequency governor, to which are added a third circuit for protection. As the unit is used in an aircraft for powering delicate components, protection is essential against overspeed, underspeed and low voltage. The characteristics of the inductor alternator used are such that protection against high voltage is unnecessary.

Newest Developments. The range of alternators already produced by de Havilland Propellers is being used in a number of current aircraft and guided weapons. Little may be revealed of the latest developments, but it is permissible to disclose that a low-speed, high-frequency, continuously rated power unit for aircraft use is now on test. This unit is directly driven by a swashplate oil motor, using return oil as the cooling medium for heat generated by the alternator. Another development is a variable-torque device which replaces the moving throttle on turbo-alternators driven by cordite gas or i.p.n. This has overcome the problem of throttle jamming caused by dirty fuels. Controller circuits are being re-designed to accommodate the latest advances in electronic techniques, and transistors are being introduced to reduce space and weight.

Comprehensive test facilities have been built up, and there are now several large laboratories engaged on alternator work. Suitably protected rigs have been built for testing units driven by each of the fuels in use.



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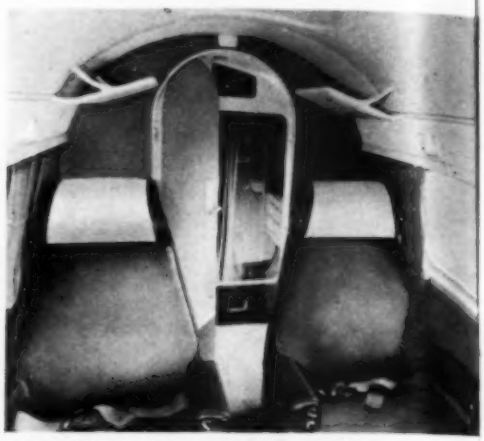
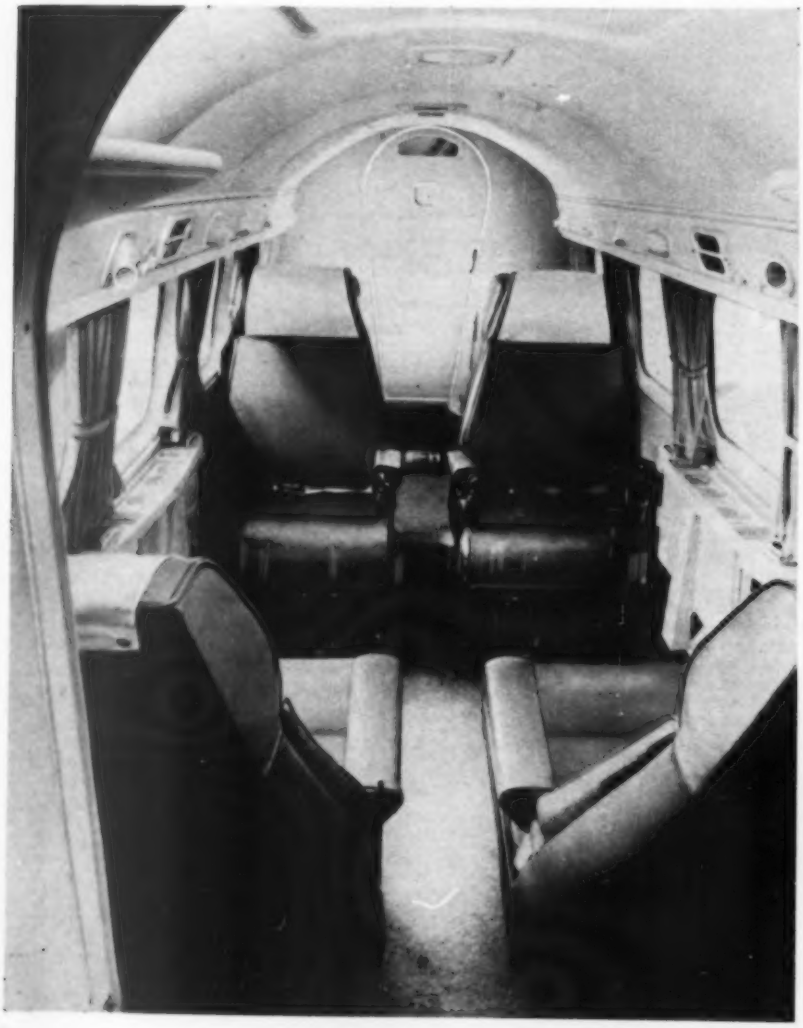


In addition to the two baggage compartments, light luggage and clothing can be accommodated in a wardrobe situated aft.



Folding tables, which can be raised singly or to form a cabin-width spread, are convenient for conference work.

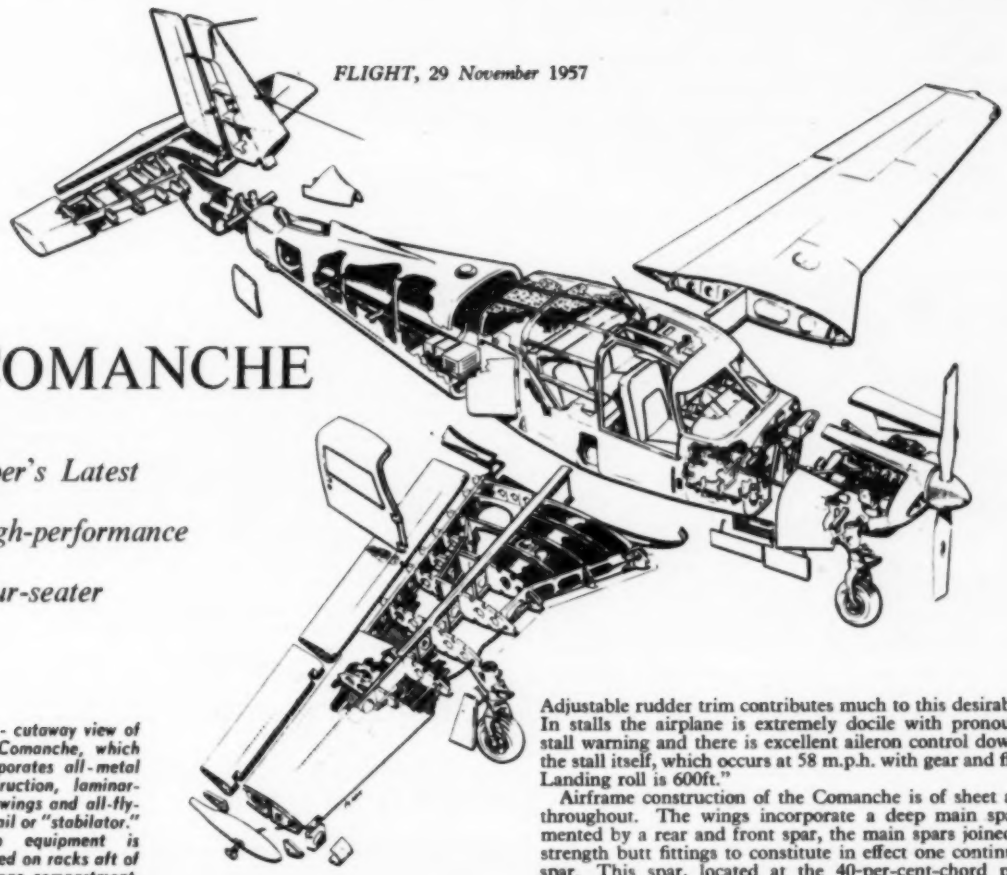
Adequate facilities for stowing and serving refreshments are provided in the cabin.

D E H A V I L L A N D

AIRCRAFT ENGINES PROPELLERS

COMANCHE

Piper's Latest High-performance Four-seater



Part - cutaway view of the Comanche, which incorporates all-metal construction, laminar-flow wings and all-flying tail or "stabilator." Radio equipment is located on racks aft of baggage compartment.

INCLUDED in the 1958 line of aircraft recently "unveiled" by the Piper Aircraft Corporation, of Lock Haven, Pennsylvania, is the brand-new Comanche, designed as a modern, low-wing, high-performance four-seat business aircraft in the medium-price class. According to Piper, it is indeed the first such aircraft to be designed and produced by a major business-aircraft manufacturer in over ten years. In performance and price (standard model costs $14,500, or about £5,200), the Comanche fits in between the high-wing Tri-Pacer and the twin-engined Apache.

The PA-24 Comanche, of all-metal construction, is powered by a Lycoming O-360-A1A engine of 180 h.p. driving a constant-speed, controllable propeller. The cabin accommodates four people and there is a separate baggage compartment. Cruising speed at 75 per cent power at 8,000ft is 160 m.p.h., and the machine has a maximum-economy cruising range of 1,100 miles or 7½ hours' endurance.

Among the Comanche's design features are a number of aerodynamic innovations which contribute to the high performance which the aircraft achieves on relatively low horsepower. The most important of these are the laminar-flow wing and the "stabilator" or flying tail. The latter comprises a one-piece horizontal surface, hinged at approximately 30 per cent mean chord and fitted with a self-compensating anti-servo tab which is adjustable in flight. This type of tailplane, which reduces the size of the horizontal control surfaces, is claimed to provide better controllability in all speed ranges and especially at low speeds.

At full load the Comanche will take off in 750ft, and it has a sea-level rate of climb of just under 1,000ft/min. Commenting on the machine's flight characteristics, the company state: "In flight the Comanche is extremely stable with exceptional longitudinal, lateral and directional stability, especially in rough air. This feature results in minimum control effort on long cross-country flights. Adjustable rudder trim contributes much to this desirable feature. In stalls the airplane is extremely docile with pronounced pre-stall warning and there is excellent aileron control down through the stall itself, which occurs at 58 m.p.h. with gear and flaps down. Landing roll is 600ft."

Airframe construction of the Comanche is of sheet aluminium throughout. The wings incorporate a deep main spar supplemented by a rear and front spar, the main spars joined by high-strength butt fittings to constitute in effect one continuous main spar. This spar, located at the 40-per-cent-chord position of maximum thickness, passes through the cabin underneath the rear seat. The airframe structure is built to withstand a load factor of 7.5.

The O-360-A1A engine is the latest in the Lycoming company's four-cylinder line. It has a compression ratio of 8.5 : 1 and uses 91-octane fuel. It is equipped with a Piper-developed cross-over exhaust system (which provides effective scavenging of exhaust gases and ensures maximum power on take-off) and a stainless-steel exhaust muffler.

Fuel is carried in two 30-gallon rubber fuel cells, one in each wing. The standard fuel capacity for four-seat operation is 50 gallons (giving five hours' endurance or 800 miles' range at maximum cruise); extra endurance can be obtained by using the full capacity of the tanks (six hours or 960 miles) or, in addition, flying at economical cruise of 147 m.p.h. to give 7½ hours or 1,100 miles. An auxiliary electric fuel pump is provided.

The tricycle landing gear, of 9ft 3in track, retracts electrically in seven seconds. It is actuated by a wheel-shaped lever on the instrument panel, and there is an emergency manual lever in case of electric failure. A warning horn sounds and a red light flashes if the pilot throttles back with the undercarriage retracted, and a switch in the left main landing-gear prevents the inadvertent retraction of the wheels while the aircraft is on the ground. When extended, the nosewheel engages with the rudder-pedal system and is steerable through a 50-degrees arc by means of the pedals. Both main and nose wheels are fitted with the same size of tyre, 600 × 6, and single disc hydraulic brakes are employed. Main air-oil landing-gear struts are interchangeable.

Dual controls are standard equipment on the Comanche, and are equipped with ball-bearings throughout. In addition to the horizontal trim-tab, a rudder trimmer is also provided. The flaps are manually operated by a lever between the two front seats, and have three positions—nine, 18 and 27 degrees. Full flap is recommended for landing, and the partial-flap position for take-off.

Short undercarriage legs and wide track are evident in this head-on ground view of the new Piper four-seater, which is powered by a Lycoming engine of 180 h.p.

In flight, the Comanche's sharp, clean lines are displayed to advantage. Of particular interest are the all-flying tail, of relatively small area, and the swept wing-root, said to give improved airflow characteristics at low speeds. Cruising speed of the machine is 160 m.p.h.

COMANCHE . . .

A total of 20 instruments can be accommodated on the centrally shock-mounted panel, and are serviced by means of a removable access plate. Space for a variety of radio equipment is provided at each side of the panel. The standard version of the machine is provided with basic flight instruments and no radio. The "custom" Comanche has a full gyro panel for instrument flight, a Narco Superhomer VOR navigation unit, V.H.F. receiver and 12-channel transmitter (with nine crystals as standard), plus an LFR-3 low-frequency receiver. The "super custom" model is equipped with a Lear ADF-2-E automatic direction finder and a Narco Omnigator Mk 2 VOR, I.L.S. and V.H.F. communications unit with a 27-channel transmitter (24 crystals standard).

The Comanche's cabin has a width of 44½ inches. The two front seats are individually adjustable fore and aft, while the rear bench seat has an adjustable back. There is a 20 cu ft baggage compartment behind the rear seat; over the compartment is a wide hat-shelf. Individual cool-air ventilators and ash-trays are provided.

Electrical power comes from a 12-volt system, with a 33 ampere-hour battery mounted in the firewall. A 35-amp generator is standard with a 50-amp unit as optional equipment. The standard lighting consists of wingtip landing-lights, navigation lights, instrument lighting and cabin dome light. Also electrically operated is the turn-and-bank indicator.

PIPER PA-24 COMANCHE

(Lycoming O-360-A1A giving 180 h.p. at 2,700 r.p.m.)

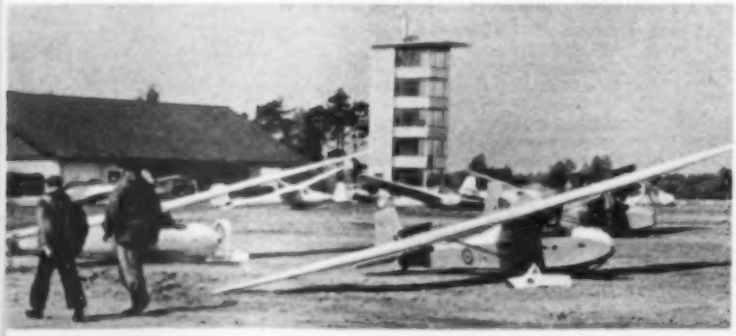
Span, 36ft; length, 24.7ft; height, 7.3ft; wing area, 178 sq ft; gross weight, 2,550 lb; standard empty weight, 1,475 lb; useful load, 1,075 lb; wing loading 14.3 lb/sq ft; power loading, 14.2 lb/h.p.; top speed, 167 m.p.h.; optimum cruising speed (at 75 per cent power and 8,000ft), 160 m.p.h.; stalling speed (flaps down), 58 m.p.h.; fuel consumption at 75 per cent power, 10 gal/hr; cruising range (75 per cent power 8,000ft, standard fuel), 5 hr or 800 miles; cruising range (optimum cruise power, reserve fuel), 7.5 hr or 1,100 miles.

CLUB AND GLIDING NEWS

THE fascination of bird flight brought a record number of members to the Kronfeld Club, London, on Wednesday, November 20, to hear a discussion by Peter Scott and to see a B.B.C. film on the subject made for the television programme *Look*. Soaring flight, flapping flight and manœuvring were splendidly illustrated by a number of slow-motion and actual-speed sequences in the film, which was followed by a general question-and-answer session. Among the intriguing aspects discussed were whether birds indulged in blind-flying, and the extent of their innate instincts of recognition and navigation.

Birds could fly blind, as an amusing story by Peter Scott proved, but they were not keen to do so. The ability to recognize other birds was a proven fact, which was why chickens reacted violently to hawks (or gliders) overhead, but not to long-necked birds such as swans (or gliders flying backwards). John Simpson contributed the story of the pilot flying the ridge at Dunstable whose sailplane was attacked by a parrot from Whipsnade. The main speaker hesitated to start on the vast subject of bird navigation, but was persuaded by the enthusiastic audience of over 100 to discuss a few examples of the complex and inexplicable facility which enables birds, by an inborn sense, to navigate by topography, the sun, and the stars.

Gliding in 2nd T.A.F.: scenes at this year's summer camp held by the Nimbus Gliding Club at the Oerlinghausen gliding centre.



A DRIVE for more members is being made this winter by the 2nd T.A.F. Gliding Association, which draws its membership from Service personnel throughout Western Germany. There are at present eight member-clubs (seven R.A.F. and one Army), and two more are to begin operation in the near future. Total membership is now approximately 250. During last year members of the Association flew a total of 810 hours from 7,654 launches, and this year's figures are expected to show a substantial increase. The member-clubs are located at the R.A.F. stations Wildenrath, Ahlhorn, Bruggen, Geilenkirchen, Gutersloh, Laarbruch, Schleswigland and Sylt, and the Royal Engineers run the B.A.O.R. Gliding Club at Hamelin; chairman of the parent Association is A. Cdre. V. D. Morshead.

The Nimbus Gliding Club at Wildenrath is the largest of the 2nd T.A.F. clubs, and its 50 members include a variety of ranks from colonels and wing commanders to privates and airmen. Subscriptions vary from £4 to £6 per year, but are to be increased next year to £6—8. Each launch costs 1s, and flying charges decrease from 1s per ten minutes (first hour) to 6d per ten minutes (third, fourth and fifth hours). As an incentive, if one were needed, soaring time after the fifth hour is free. The club operates 13 aircraft, but all of them are 15-20 years old and at present only four—Weihe, Rhönsperber, Grunau and Goevier—are serviceable. The other types are a Meise, Rhönbussard, Rheinland, Tutor, S.G. 38, Mü 13, a second Rhönsperber and two more Grunaus.

The age of aircraft and equipment, and a shortage of funds, are the biggest problems affecting the Nimbus club and the Association as a whole at the present time. Apart from the types already mentioned, the aircraft operated include Kranich two-seaters, Minimoas and Meises, and six Kirby Cadet Mk 2s which, received from the U.K. last year, have helped to relieve the overworked Grunaus. All clubs are suffering from an acute shortage of two-seaters. Although enthusiasm is high, unserviceability resulting from veteran equipment limits the amount of flying; shortage of funds makes it difficult to offset losses; and repairs and maintenance consume a high proportion of income.

Hitherto the 2nd T.A.F. Central Fund has given an annual grant to the Association, and this year the Army has also made one, but the prospects for future income (apart from subscriptions) are uncertain. Unlike the R.A.F. Gliding and Soaring Association in this country, the 2nd T.A.F. Association receives no assistance from the Kemsley Flying Trust, and it does not wish to raise subscriptions any higher for fear of deterring the very people it wishes to encourage to fly. But, despite these problems and the general uncertainty which has affected all activities in 2nd T.A.F. since the publication of the Defence White Paper, the Association is looking forward with enthusiasm and confidence. As a concrete step, it is hoping to revive the 2nd T.A.F. gliding championships next year. Its efforts certainly merit official support.

WESSEX

Westland's Napier-Gazelle-powered Helicopter for the Royal Navy

THE latest horse from the Westland stable (it is far too large to be described as a foal, even at birth) represents an achievement which is much more than the outcome of taking a manufacturing licence to build a new American type. It is the first practical realization in Great Britain of the helicopter designer's long-expressed intention to apply the advantages of the gas turbine to large helicopters and, as such, it is undoubtedly the precursor of a new species of rotating-wing aircraft. Gas turbine performance characteristics lend themselves remarkably well to the helicopter's requirements; designers of a number of smaller types have already made the change and gained considerable advantage by so doing. The advantages likely to accrue from the installation of the Napier Gazelle free-shaft turbine in the Westland Wessex should be even greater by comparison.

The events leading up to the first flights of this new machine reflect credit on both the airframe constructors and the engine manufacturers. In April 1956, Westland's chief test pilot, W. H. ("Slim") Sear, went to the U.S.A. to carry out a short conversion course on a standard production-model S-58 helicopter which had been purchased by the British company as a private venture. The machine was then shipped to Yeovil, where it was reassembled in its original form with the Wright Cyclone powerplant. It was flown for the first time in the United Kingdom on June 24 of last year.

A number of demonstrations were given to potential customers, including the three Services, and this flying totalled some 70 hours. During one demonstration to the Army, 22 armed troops were carried with a full fuel load. As a result of these demonstrations, Westlands received a preliminary production order from the Royal Navy and work on anglicizing the American design began. Although initial production of the Wessex will be to meet the Navy contract, the machine is being built to A.R.B. specifications so that a C. of A. for commercial operation will follow eventually.

The Napier Gazelle, which had then been under development for two years, was selected as the most promising British powerplant to replace the Wright Cyclone. While re-design was in progress an experimental installation of one of the first prototype engines was made in Westland's S-58 to gain experience of the unit and its performance in the helicopter rôle. The Gazelle-powered S-58 began engine running in March 1957, some six months after the conversion was begun, and made its first flight on May 17. The first power unit employed was the type NGa.11, delivering 1,120 s.h.p., as compared with the original 1,525 h.p. delivered by the Wright Cyclone.*

Shortly before the S.B.A.C. Show a more advanced version of the Gazelle was installed. This was the NGa.13, delivering 1,450 s.h.p. and incorporating modifications to provide greater efficiency at slightly higher r.p.m. The new engine also embodies an accelerator control device which regulates the fuel flow in relation to r.p.m., thus preventing the possibility of turbine stall through excessive use of throttle. [*Contd. overleaf*

**A detailed description of the Napier Gazelle free-shaft turbine appeared in "Flight" of May 10, 1957.*

The standard Sikorsky S-58 (Wright Cyclone piston-engine) which was brought to this country for the initiation of the Wessex programme. In the heading picture it is seen after conversion to Napier Gazelle free-turbine power. Here the air intake is apparent; it has since been enclosed by the re-designed nose shown in the cut-away and general-arrangement drawings on pages 840-841.

WESSEX . . .

It is intended to use this powerplant for the first production models of the Wessex itself. Taking into account the considerable weight-saving of the Gazelle installation and the percentage of power saved by the absence of an engine-cooling fan, this shaft horsepower should give the British version a slightly improved performance in comparison with the Cyclone-powered S-58. The fully developed Gazelle turbine is reported to have a power potential in excess of 1,700 s.h.p.

Performance figures attained so far with the Gazelle-powered S-58 have been well up to the company's expectations and indicate a promising future for the production version. The machine has been put through the entire range of helicopter manœuvres, including forward speed up to the maximum of 125 kt and rearward speeds of over 35 kt. Everyone who has seen or flown in the machine has remarked on the noticeable reduction in noise and vibration afforded by the turbine engine. Taxying on the ground is greatly facilitated by the tailwheel undercarriage; it is even possible to taxi backwards into a parking space. Autorotational characteristics are, of course, no different from those of the standard piston engine version.

Characteristically, the turbine engine needs no warm-up period and this feature has been strikingly demonstrated a number of times by timed take-offs. The best time so far achieved has been 30 sec to leave the ground from the moment of pressing the starter button. The time for actual rotor acceleration from stationary to take off r.p.m. was 15 sec. The fact that the free turbine principle makes it possible to dispense with a clutch is largely responsible for the rapidity of these starts. The turbine is "wound up" with the rotor brake on; the igniters are then lit and when an idling speed of 10,500 r.p.m. is reached the rotor brake is released and the power turbine takes up the drive. Rotor engagement is thus smooth and swift.

Production plans for the Wessex itself are well under way and the company expect that the first batch will be ready for service towards the end of next year or early in 1959. Eventually extensive production is envisaged and is being provided for. The design follows closely that of the American version, with minor modifications to accommodate the different power unit and the resultant weight-distribution changes. There are also slight variations in material specifications to meet British requirements.

Fuselage. Monocoque construction is used throughout the fuselage with the exception of the welded-steel-tube pylon which carries the main gearbox and, above it, the rotor head. The two forward legs of the pylon are located at strong-points near the main transverse frame which marks the forward limit of the cabin space and also the fireproof bulkhead. The main undercarriage oleo leg attachments are also located at this frame. The frames and much of the skin is of Duralumin, but some use of magnesium-alloy sheet is made in certain covering panels where both sides of the panel are plainly and readily visible for inspection purposes.

The spacious cabin, measuring 13ft 6in long by 5ft 3in wide has 6ft headroom throughout. It is entered by a large sliding door on the starboard side, above which is fitted a fixed-position hydraulic winch capable of lifting 600 lb in the rescue rôle. There are two windows on each side of the cabin, one of those on the starboard side being in the door itself. The two port windows are jettisonable to provide an emergency exit on that side of the machine, while half the door is jettisonable on the starboard side. The ample space available allows easy access to the two pilots' seats in the cockpit through hatchways at the forward end.

In the centre of the after bulkhead a door leads to a rear compartment which, in the American S-58, is used to house radio and electrical equipment. In the Wessex, the lighter installation of the Gazelle turbine—some 600 lb has been saved—has necessitated the transfer of this equipment to a forward position in order to maintain correct weight distribution. The after compartment will therefore be occupied by the combustion heater, which supplies warm air to the cabin through ducts. These ducts are extended into the cockpit above, to feed warm air to the windscreen de-misters behind the instrument panel. Controllable by the pilot, the heater draws a small supply of engine fuel from the main tanks. If only the heater fan is set in motion, without the fuel pump, ventilating air comes through the same ducts.

From the after compartment a walkway extends internally through the length of the tail cone as far as the tail-folding hinge points, to give access to the tail-rotor drive shaft.

Fitted just forward of the hinge point, the tailwheel is fully castoring. For an autorotative landing it can be locked in the central position by a control in the cockpit.

That portion of the tail cone aft of the hinge point, known as the tail-rotor pylon, can be folded forward to lie parallel with the fuselage for stowage purposes. It is attached to the tail cone itself at four points, two of which on the port side comprise the hinge while the two on the opposite side carry the locking pins to secure the attachment. Mechanical arrangement of the locking device is such that a clearly visible red warning flag extends from the starboard side of the tail cone if the locking pins are not secured. Then fully folded, the tail rotor pylon can be locked to the side of the tail cone.

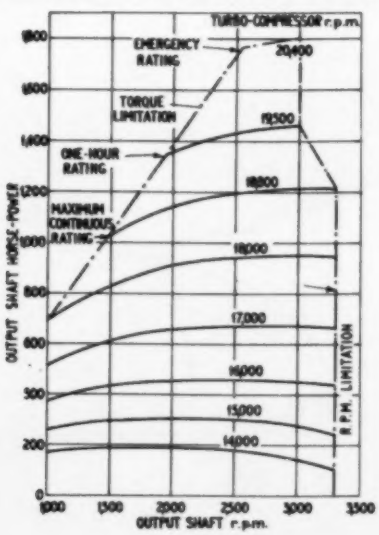
Ground crew can perform the folding operation very simply. It does not involve any control or transmission coupling, since the tail-rotor pitch controls from the rudder pedals are not disconnected by the action and the tail-rotor drive shaft incorporates a spring-loaded coupling which splits when the tail is hinged forward and automatically slips into place when it is locked back into position again. The tail fin carries a small fixed horizontal surface to improve fore-and-aft stability in cruising flight.

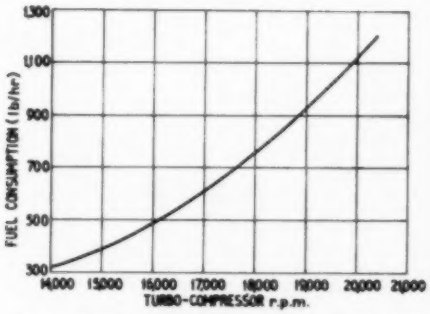
Powerplant Installation. The only way in which the fuselage design of the Wessex has been changed from the original American S-58 pattern is by the lengthening of the engine bay in the nose by approximately one foot to accommodate the increased length of the Gazelle. In the converted S-58 now flying, Westlands have retained the clam doors in the nose, suitably tailoring them to fit the air intake which now extends below. In the anglicized version the shape of the nose has been slightly elongated—the pilots' line of vision remains unaltered—and the inspection doors have been completely redesigned to allow appropriate accessibility to the turbine.

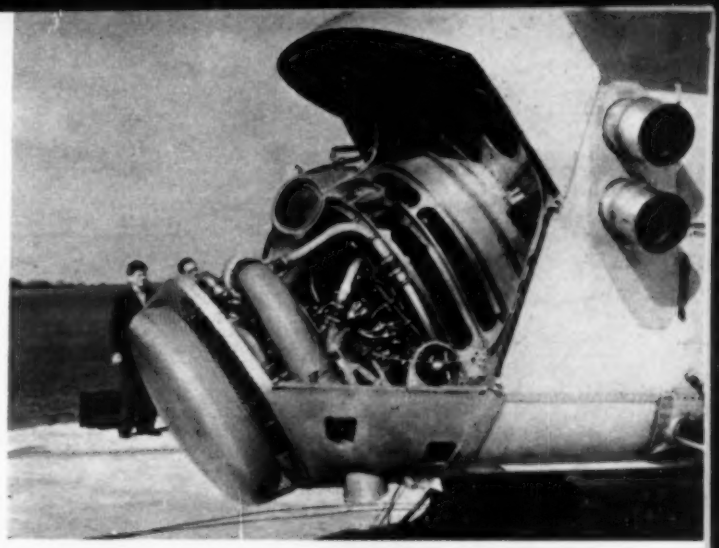
To avoid any necessity for redesigning the transmission system, the piston-engine mounting angle of 35 deg to the horizontal has not been altered. As the turbine has a much smaller diameter than the piston engine it replaces, considerable space is left available in the engine bay. Since, as already stated, the Gazelle installation is fully 600 lb lighter than that of the Cyclone, the space has been used to provide two large radio and electrical equipment compartments immediately above the turbine to compensate for the resulting changes in weight distribution. The forward section of the nose now hinges upward to expose the

The ingenious tail-folding system, in conjunction with the folding of the main rotor blades, reduces the overall length of the Wessex by no less than 27ft 4in.

Gazelle NGa.13 estimated performance (static conditions, sea level, I.C.A.N. atmosphere).







Napier Gazelle NGa.13 fuel consumption (static conditions, sea level, I.C.A.N. atmosphere). Right, installation of the NGa.13 powerplant in the S-58.

entire front of the engine; two large side-panels hinge downward, one port and one starboard, and these not only allow access to either side of the turbine for accessory maintenance or inspection but they also incorporate steps and may be used as platforms on which engineers may stand to service the radio and electrical equipment in the compartments above; covers for the two last-mentioned items comprise the upper nose-compartment skin, hinged at the centre line so that either side may be opened upward for servicing; and, finally, removable panels on the under side of the fuselage provide additional access to the turbine.

Commendable ingenuity has been displayed in the mounting of the turbine itself. A track is fitted at the mounting angle of 35 deg on each side of the centre line of the engine bay, and the upper engine bearing torque frame has two rollers which run up the tracks and are located at the top by locking pieces. The upper bearers take all except axial loads. These are accepted by the lower bearers, which take the form of a tripod picking up on lugs in the lower end of the nose compartment. As the engine is rolled up the tracks it passes through a circular aperture in a second fireproof bulkhead approximately four feet forward of the main fireproof bulkhead between the cabin and engine bay.

On the turbine itself a continuation of the second fireproof bulkhead is fitted over the flame-tubes in the form of a "dustbin," the open end of which seals off the circular aperture when the engine is in position. Exhaust gases escape through manifolds protruding from either side of the nose. Thus, the hot part of the turbine is contained in a stainless-steel-lined fireproof box which segregates it from the cabin at the upper end and from the engine accessories and air intake at the lower end.

This arrangement has been adopted to facilitate rapid engine change. To mount the turbine, a removable channel is fitted horizontally along the top of the engine bay immediately below the hinged-up nose door. Two "roller skates" (also items of removable ground equipment) run in this channel with the engine slung below them. The engine is moved into the nose horizontally until the torque-frame rollers locate in their tracks; it is next turned upward until the rollers reach the top limit of the tracks and are locked in position; then the lower engine bearing tripod is located to its lugs and the horizontal channel can be removed.

One advantageous feature of the system is that the engine-oil cooling tank, the engine-driven oil-cooler fan and the oil cooler itself are all located on the engine unit, forming an integral part of the engine accessories. Thus it is not necessary to break the oil-cooling circuit when carrying out an engine change.

Detachable panels provided in the "dustbin" allow the igniters in the flame-tubes to be reached, and similar panels in the cabin fireproof bulkhead give access to the fireproof box.

Bag-type fuel tanks are disposed beneath the cabin floor in a similar manner to those in the American S-58, with the exception that the smaller diameter of the turbine has permitted space below the fireproof box for an additional, triangular, tank in the forward group. The after group comprises five separate tanks, and the forward set consists of six. The booster pump is centrally disposed. Although fuel is used from the forward group, it is the after set which drains first, because a small amount of air under pressure is bled from the turbine to provide a means of transferring fuel forward from the after group during flight. Capacities are 160 Imp gal forward and 110 aft. In addition, an extra 30-gal tank can be included in the after group for rôles demanding increased range. A scheme is also being prepared for fitting drop tanks, one on each side of the fuselage.

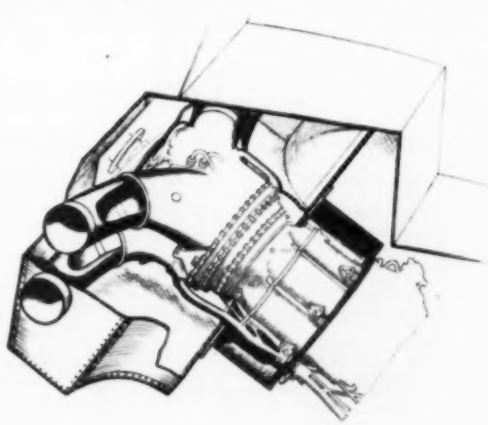
Power Transmission. From the power turbine at the upper end of the installed engine the drive is taken up through a tunnel to the main gearbox mounted in what is known as the transmission compartment, above the cabin roof. (It is interesting to recall that the direction of rotation in the Gazelle as originally developed was the opposite to that required for the Wessex. Rotation was reversed by the simple expedient of providing the power turbine with blades which were a mirror image of the original ones. This modification was successfully carried out in less than one week. Incidentally, an additional advantage gained by reversal is that gyroscopic moments in the turbine are now partially cancelled.)

The reduction gearbox is retained at the output end of the turbine. In the S-58 installation now flying it provides a reduction of 6:1, giving a normal drive-shaft speed of 2,500 r.p.m. at a free-turbine speed of 15,000 r.p.m. For the Wessex itself, modifications are in hand to increase the reduction to approximately 7:1, thus giving the same drive-shaft speed at a free turbine speed of approximately 17,000 r.p.m. A freewheel unit is included in the transmission between the turbine output and the main gearbox. Also included in this power drive-shaft is a low-friction sliding coupling to allow for axial expansion in the power unit at high temperatures.

The main gearbox is raised slightly from the cabin roof in order to reduce noise. It provides a first-stage reduction through spiral bevels to the second stage, which comprises epicyclic single helical gears arranged as a conventional planet system to transmit the drive up to the rotor head. The total speed-reduction ratio is in the region of 11 : 1, giving a normal operating speed at the main rotor of 222 r.p.m. The tail-rotor drive is taken off at the first stage to give a shaft speed of 2,800 r.p.m. and a tail-rotor speed, after further reduction in the tail-rotor gearbox, of 1,318 r.p.m.

In the transmission compartment are those accessories which derive their drive from rotor sources. These include the main-gearbox oil cooler and fan, the latter operated by a belt drive from the tail-rotor drive shaft; two hydraulic pumps providing separate sources of power for the power-operated flying controls and for the air/sea rescue hoist; the main-gearbox lubrication pump; a 12 kW generator and its cooler fan; and the rotor-head tachometer pick-off. The main rotor brake mechanism is also in this compartment, the hydraulically operated, disc-type brake being applied to the tail rotor drive-shaft just behind the main gearbox.

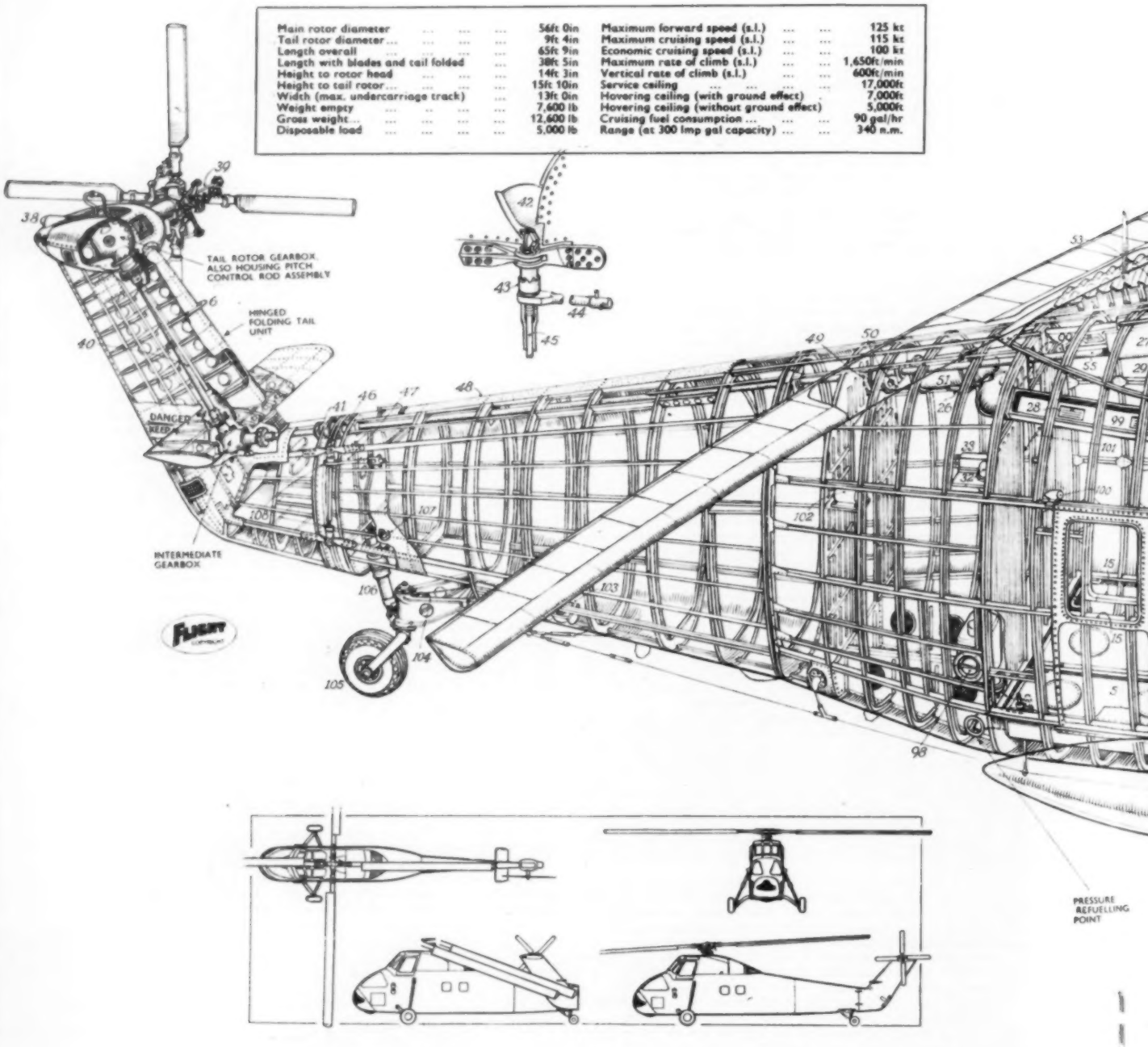
(*Continued on page 842, after cut-away drawing of the Wessex*)



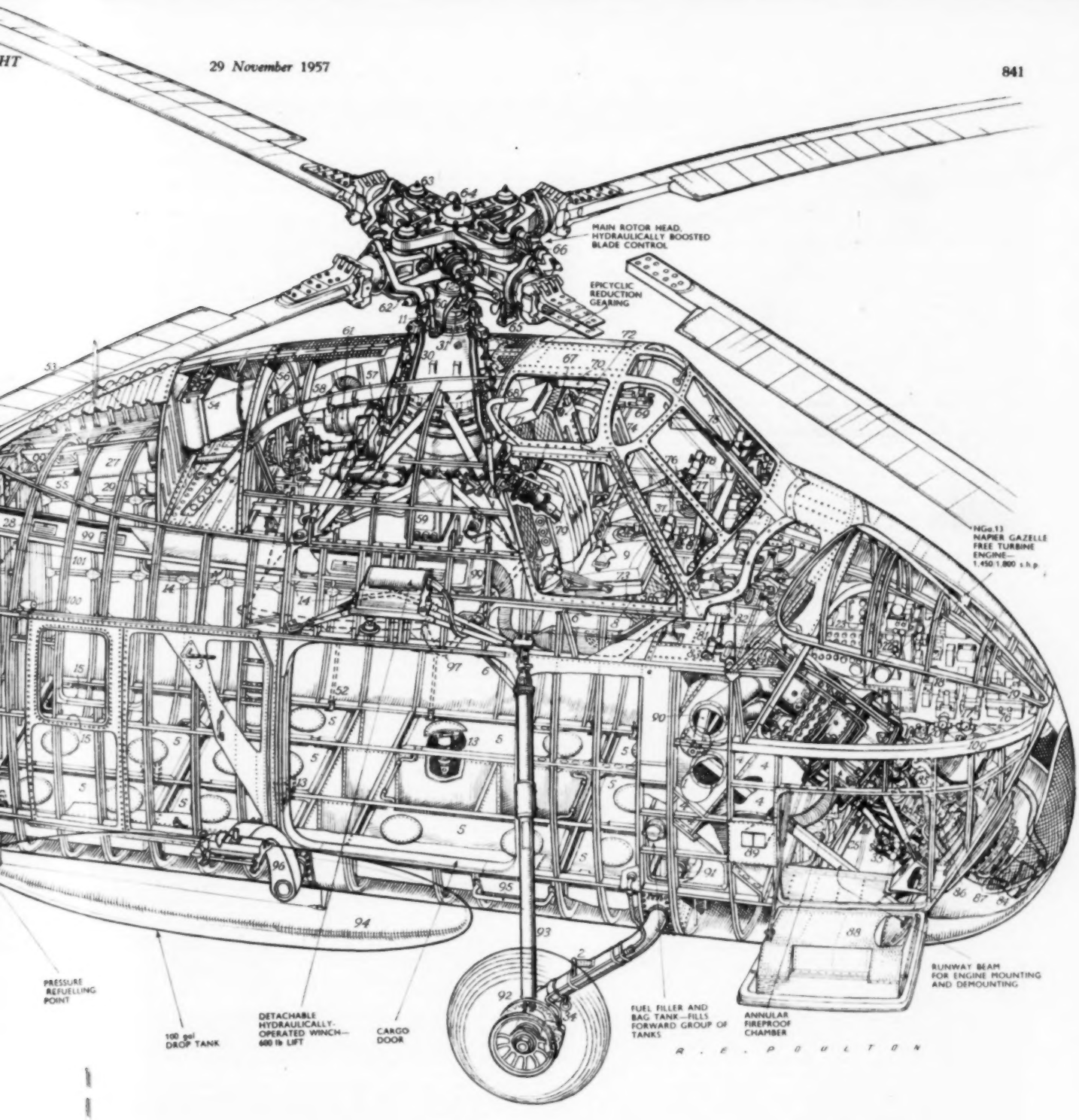
The stainless-steel fireproof container which isolates the hot section of the powerplant. Surrounding details of structure and equipment have been omitted from this sketch for the sake of clarity.

WESSEX . . .

Main rotor diameter	56ft 0in	Maximum forward speed (s.l.)	125 kt
Tail rotor diameter	9ft 4in	Maximum cruising speed (s.l.)	115 kt
Length overall	65ft 9in	Economic cruising speed (s.l.)	100 kt
Length with blades and tail folded	38ft 5in	Maximum rate of climb (s.l.)	1,650ft/min
Height to rotor head	14ft 3in	Vertical rate of climb (s.l.)	600ft/min
Height to tail rotor	15ft 10in	Service ceiling	17,000ft
Width (max. undercarriage track)	13ft 0in	Hovering ceiling (with ground effect)	7,000ft
Weight empty	7,600 lb	Hovering ceiling (without ground effect)	5,000ft
Gross weight	12,600 lb	Cruising fuel consumption	90 gal/hr
Disposable load	5,000 lb	Range (at 300 Imp gal capacity)	340 n.m.

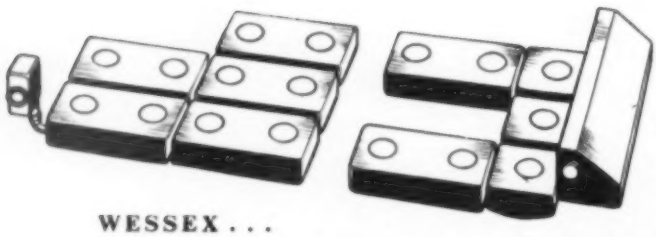


1 Exhaust stubs
2 Step
3 Forward door-section jettison lever
4 Main fireproof chamber
5 Bag tanks under floor (ten)
6 Hand grips
7 Auxiliary servo-unit linkage
8 Transmission tunnel
9 Pilot (starboard) and co-pilot
10 Console
11 Pitch-control rod
12 Stationary scissors
13 Fuel-gauge unit
14 Two cabin windows (port side), emergency jettison
15 Two cabin windows (starboard side), one in cargo door, emergency jettison
16 Varley accumulator
17 Contactor
18 Differential relay
19 Time-delay switch
20 Magnetic relay
21 Circuit breaker
22 Inverter
23 Control panel
24 Tank for i.p.n. starter (location dotted)
25 Engine mounting truss
26 Exhaust air outlet from heating system
27 Tail-rotor transmission tunnel
28 Heat-admission grille (four in cabin duct)
29 Vacuum flask
30 Servo jacks
31 Stationary star
32 Compass gyro unit
33 Compass amplifier
34 Mooring points
35 i.p.n. starter
36 Personal convenience
37 Cabin-heater control
38 Tail light
39 Pitch beam
40 Pylon drive shaft
41 Fold indicator (see also 42-45)
42 Red warning segment (protrudes when locking pin is withdrawn)
43 Ratchet sleeve
44 Ratchet-lever-withdrawing locking pin
45 Locking pin
46 Tail-rotor drive shaft disconnection coupling
47 Ratchet-lever for tail fold
48 Tail-rotor servicing walkway (when tail folded)
49 Air intake for heating system (dotted)
50 Fan chamber
51 Heater chamber
52 Fuel tank vents
53 Louvred canopy fairing
54 Transmission-oil cooler
55 Tail-rotor transmission shaft


MAIN ROTOR HEAD, HYDRAULICALLY BOOSTED BLADE CONTROL
EPICYCLIC REDUCTION GEARING
NGe.13 NAPIER GAZELLE FREE TURBINE ENGINE— 1,450/1,800 s.h.p.
RUNWAY BEAM FOR ENGINE MOUNTING AND DEMOUNTING
PRESSURE REFUELLING POINT
100 gal DROP TANK
DETACHABLE HYDRAULICALLY-OPERATED WINCH— 600 lb LIFT
CARGO DOOR
FUEL FILLER AND BAG TANK—FILLS FORWARD GROUP OF TANKS
ANNULAR FIREPROOF CHAMBER
R. E. POULTON

ing locking
connection
ld
walkway
ng system
shaft

56 Oil-cooler blower
57 Generator blower
58 Rotor-brake
59 Autopilot
60 Azimuth star
61 12 kW generator
62 Pitch-change horn
63 Vertical hinge pin
64 Damper reservoir
65 Anti-flapping droop restrainer
66 Blade damper
67 Free-wheel unit
68 Pitot tube
69 Rotor-brake lever
70 Overhead control panel
71 Map case
72 Autopilot test panel
73 Bulged side window for pilot, emergency jettison
74 Folding seats giving access from cabin to flight deck
75 Screen wiper
76 Collective-pitch control
77 Cyclic-control stick
78 Electrical controls
79 Drive to main-rotor gearbox
80 Pedal adjustment
81 External duct for wiring
82 Wheel-brake master cylinder
83 Tail-rotor flight-control pedals
84 6 kW generator (provision for another)
85 Engine air filter
86 Integral hydraulic pump
87 Hydraulic pump for flying controls
88 Inspection door and servicing platform
89 Engine cooling air inlet
90 Engine trolley cradle and torque frame
91 Undercarriage inboard bearing
92 Disc brake (32in wheels)
93 Oleo pneumatic undercarriage strut
94 Drop tank (compressed air feeds fuel to collector tank)
95 Mounting step
96 Carrier arm
97 Hinged canopy cover (dotted) acts as servicing platform
98 Fuel filler and header tank for rear group of tanks
99 Cabin heating duct
100 Navigation light
101 Safety curtain across aperture
102 Autopilot barometric altitude control
103 Compass detector unit
104 Tailwheel lock
105 Fully castoring tailwheel
106 Pneumatic tailwheel strut
107 Air pressure for tailwheel strut
108 Tail pylon fold-locking assembly
109 Oil-cooler fan



Arrangement of bag-type fuel tanks in the Wessex: Forward (right) and rear groups, with filler and header tank on left.

WESSEX . . .

The tail rotor drive shaft is taken back through the tail cone to an intermediate gearbox beyond the tail hinge-point and thence up to the tail-rotor gearbox.

The transmission system is essentially similar to that in the American S-58, with the exception that the absence of clutch allows a marked simplification.

Rotor Head and Blades. The main rotor head follows the classic Sikorsky design-pattern. It is of light alloy construction and incorporates offset flapping and drag hinges employing Timken tapered roller bearings. The flapping-hinge offset gives the machine a remarkably good c.g. range, comparable to that on larger fixed-wing aircraft. The limits are from 9 deg aft to 7 deg forward of a vertical datum line below the centre of the rotor head. The head has a built-in 3-deg forward tilt which reduces the characteristic helicopter nose-down attitude in forward flight. Fuselage attitude on the ground is approximately 1 deg nose-up and, with the aircraft normally loaded, the hovering attitude is also slightly nose-up.

The larger size of the rotor head has enabled a much neater design to be effected than in earlier models. The drag-hinge dampers are concealed within the head and, in contrast to the arrangement in previous models, a common reservoir for damper fluid is mounted centrally on top of the head. Spring-loaded centrifugal droop and anti-flapping stops are fitted. The latter prevent blade-sailing when the rotor is being started or stopped in high winds. As a result it is possible to operate the Wessex in surface winds of up to 50 kt without danger of excessive blade-coning. The blades are folded by a method similar to that in the Whirlwind.

Rotor-head control is also of conventional Sikorsky design, incorporating a tilting swashplate actuated by two lateral and one fore-and-aft hydraulic jacks, with the azimuth star above carrying the connecting rods to the blade-pitch arms.

Both main and tail rotors are four-bladed and both have all-metal blades. The main rotor is 56ft in diameter. Blade construction embodies a D-shaped extruded alloy leading-edge spar, with the trailing edge attached in sheet-alloy "pockets." The tail rotor is of 9ft 4in diameter and its blades are fashioned from sheet alloy. A conventional tail-rotor spider, operated by rudder pedal movements, controls the collective pitch of the tail-rotor blades. Range of movement is greater than in previous helicopters, being from plus 30 deg to minus 20 deg. Hydraulic damping is incorporated in the rudder-pedal control run to prevent excessive loads being applied suddenly to the tail-rotor by the pilot.

Cockpit and Control Systems. The basic cockpit layout of the Wessex is essentially similar to that of the American S-58, but there are naturally differences in the engine instruments and controls. Access is normally gained to the cockpit through the two hatchways at the forward end of the cabin, but external steps are also provided to enable the pilots to climb up and enter through the sliding windows on each side. This method will be useful when the helicopter is engaged on freighting duties and the cabin is loaded with bulky equipment.

Full dual control is fitted, with the right hand for cyclic-pitch control and the left for collective-pitch and throttle lever. The captain's position is on the starboard side. The rudder pedals carry differential toe brakes operating on the main wheels, and a parking brake lever is located centrally between the two pilots. Fuel cocks and fuel transfer and pressure controls are on the central console, while the rotor brake lever is mounted centrally overhead. The cockpit is, in fact, a slightly larger version of that in the Whirlwind, and visibility is substantially the same. The side panels are slightly bulbous, making it possible to see directly aft or below by leaning over in the seat. As in the Whirlwind, the rudder pedals are adjustable for leg length.

Two separate hydraulic servo-systems, primary and auxiliary, are provided to guard against control-system failure. All controls have duplicate power operation with the exception that the rudder pedals are connected only to the auxiliary system. The hydraulic pump supplying power to the primary system is driven by the main gearbox (and, therefore, remains in operation during autorotation) and the auxiliary-system pump is engine driven. The two systems come together to actuate the main control jacks at the swashplate. System pressure is relatively low, at a normal operating value of 1,400 lb/sq in. Both systems are normally in operation at the same time during flight. Thus, in the event of failure of one system the other is already coupled. A three-position switch on a control box on the captain's collective-pitch lever enables either system to be switched out if desired.

The other switches on the collective-pitch lever control the operation of the landing light.

On the cyclic-pitch stick hand-grip are placed another series of switches, controlling the operation of the hydraulic hoist, radio and intercom, and the autostabilizer and stick-trim systems. The last-mentioned can be used irrespective of whether autostabilization is switched in or not. Stick-trim is brought into operation by a switch on the overhead cockpit panel. The system applies an artificial spring feel to the stick and holds it lightly in a central position. Control movements away from the central position will meet an increasing artificial stick-force. If a new stick position is required for a different flight condition the stick-trim button on the hand grip is depressed whilst the change is being made, and then released at the new stick position. Thus the datum of the artificial spring-feel system is reset and will hold the stick in the new position.

Autostabilization in the S-58 is a Sikorsky system with Lear gyro and amplifying components. This equipment will also be fitted in the Wessex. It is primarily a manœuvring-type system, but it does also perform the functions of the conventional automatic pilot. The system control panel is placed centrally on the instrument panel within reach of either pilot. Autostabilized control channels in roll, pitch and yaw are provided, with appropriate trimming facilities, together with barometric control of altitude. The system works through the pilots' standard controls and can be overridden by the pilot. The button on the cyclic-stick hand-grip is provided so that by depressing it the pilot can turn the helicopter on to a new heading and release the button, when the aircraft will maintain the new course; otherwise the autopilot would bring it back to the original heading after a control movement. A similar device, in conjunction with which the hand-grip button may also be used, is provided on the rudder pedals. In this case it takes the form of a micro-switch which cuts out the autostabilizer yaw channel whenever the pilots' feet are placed on the pedals. The autostabilizer operates through the auxiliary servo system.

Further extensions to the autostabilization system to facilitate the handling of the helicopter in its anti-submarine rôle are also included.

The remaining instruments on the instrument panel are conventional, including standard blind-flying equipment and a radio altimeter. The turbine installation calls for a number of engine instruments not normally seen in helicopters, such as jet-pipe temperature gauges, and of especial interest is the torquemeter gauge which takes the place of the conventional boost or manifold-pressure gauge. The torquemeter itself is located in the turbine reduction-gear casing and permits exact measurements of the power output of the turbine drive shaft. All instruments on the panel have pillar lighting.

General Operating Considerations. In the Westland Wessex the Royal Navy will have a helicopter which is certain to afford considerable operational advantages over existing equipment. Some idea of the improvements may be gained by study of this comparative table:—

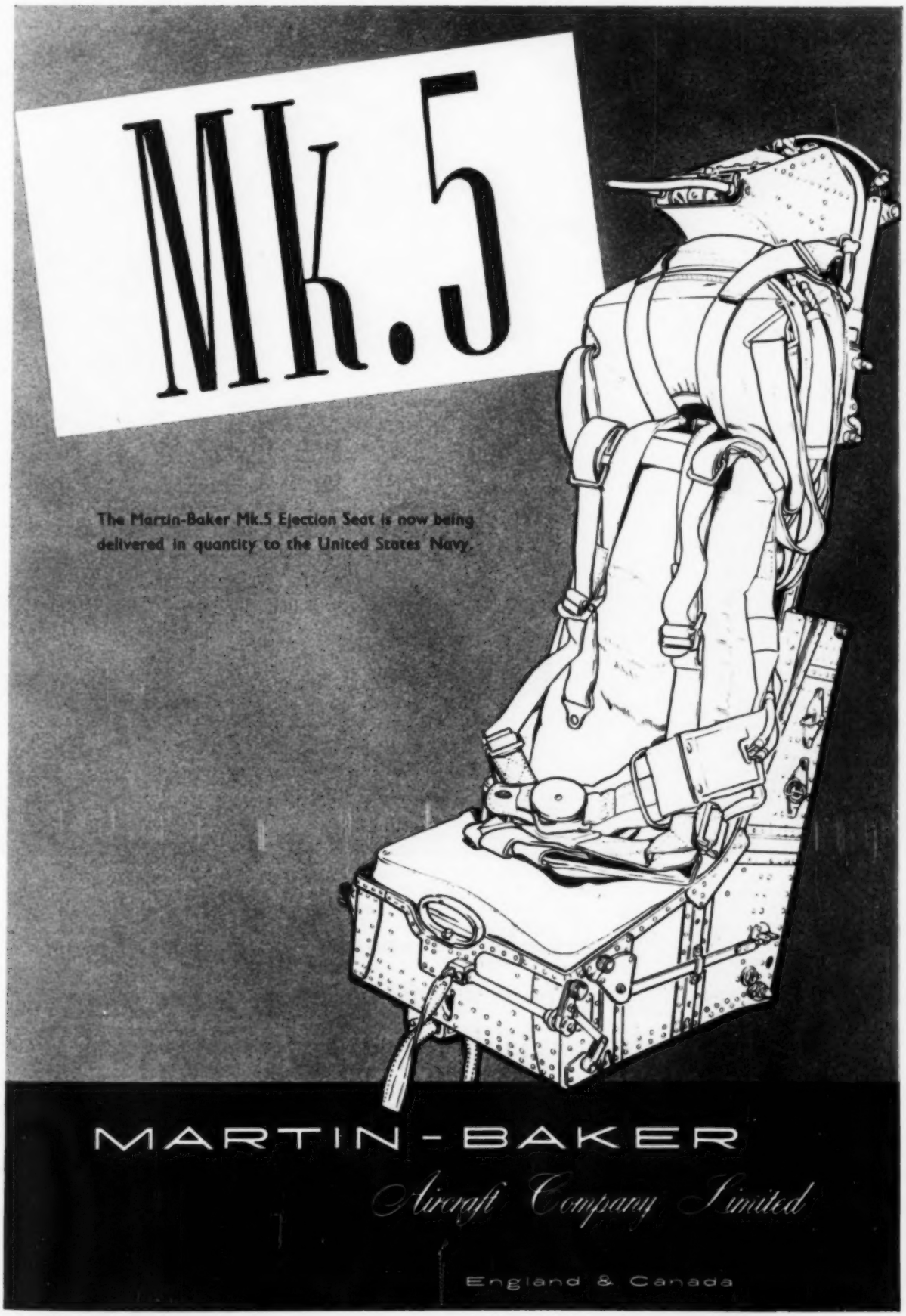
	Whirlwind	Wessex
Normal maximum speed (kt)	95	125
Normal cruising speed (kt)	80	100
Maximum sideways-flight speed (kt)	15	35
Maximum rearward-flight speed (kt)	15	30-35
Maximum wind speed for safe operation (kt) ...	35	50
Disposable load including fuel and crew (lb) ...	2,510	5,000

The obvious advantage of doubling the lifting capacity with the larger machine opens up new operational prospects in the carriage of anti-submarine detection and strike weapons. Equally important is the ability to continue operations under adverse weather conditions.

The figures for disposable load must obviously be reduced to allow for pilot and fuel, but the Wessex has provision for an external load-carrying sling on which bulky freight can be loaded to the extent of 4,000 lb.

The Napier turbines in production aircraft will be adapted to operate on Avcat, the standard Naval turbine fuel, thus obviating the need for a carrier to have special fuel for her helicopters. The modification merely entails a recalibration of the fuel system to allow for the different density; the operational efficiency of the turbine is not impaired. B.T.H. cartridge-type starting (i.p.n.) will be used.

Alternatives to the anti-submarine rôle are rescue, communications, troop transport and casualty evacuation. As an ambulance, the Wessex can carry eight stretcher cases in two tiers of four on either side of the cabin. For civil use the helicopter can be equipped with accommodation for 12 passengers and luggage in addition to the crew of two—as, indeed, is already being done by the S-58s on inter-city operations with Sabena on the Continent and New York Airways in the United States.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MISSILES AND AIRCRAFT

Inaugural Lecture of the R.Ae.S. Guided Flight Section

SIMILARITIES and differences in the respective development of guided weapons and manned aircraft were discussed by Mr. J. E. Serby, C.B.E., B.A., F.R.Ae.S., in the first lecture to be held by the newly formed Guided Flight Section of the Royal Aeronautical Society in London on November 21. The title of the lecture was *Guided Weapons and Aircraft—Some Differences in Design and Development.*

The defensive guided weapon had throughout its evolutionary life been dependent completely on a radar environment, the lecturer pointed out. In the interception phase, however, the manned fighter had closely approached g.w. philosophy, and the need for a human pilot had rested more and more on the need to deal with take-off and landing.

In the field of aerodynamics, the most striking difference was that the g.w. opted out of all the difficulties of take-off and landing. It was not concerned with landing, and as regards take-off it could be accelerated very rapidly by a launching boost which would take it up to a speed at least one-half of its desired cruising speed. The g.w. was fortunate in another major respect, in that it avoided almost all transonic problems by virtue of its high acceleration.

In the disposition, shape and size of wings and tail, the g.w. was at first sight markedly different, but much of this apparent difference arose from the fact that the missile could operate at a much higher wing-loading, so that the relative wing area was much smaller. A number of missiles incorporated moving wings. The inertia effects were here much lower, and so lift and hence manœuvre acceleration could be achieved more quickly; in addition the body incidence remained low, which in turn gave a number of advantages. These were offset by the increased wing area needed for the same lift because of the lift interruption at the centre section; and an added weight penalty arising from the heavier wing-actuating mechanism. As usual, the designer's choice was a compromise.

The importance of minimizing the drag of a missile depended on the type of weapon. At one extreme there was the ballistic missile where, on average, there was a considerable excess of thrust over drag and the important factor was a high acceleration before the thrust was cut off. Only while the missile was climbing through the atmosphere did the drag have significance, and the result was that a ten per cent increase in drag would reduce the range by about 0.5 per cent only. At the other extreme was the longish-range surface-to-air g.w., where a considerable part of the flight was likely to be at cruising speed and in the atmosphere. In these conditions aerodynamic efficiency was demanded and, since the percentage decrease in range approximated to the percentage increase in drag, a reasonable lift/drag ratio must be achieved.

As far as weight was concerned, a study of growth factors could give much information. The growth factor was the rate of increase of total missile weight per unit increase in payload weight (warhead, fuse and guidance), assuming the restoration of the original performance. For air-to-air and short-range surface-to-air missiles, this growth factor F, or dW/dP, was between 2.5 and 3 (see Fig. 1), compared with values of 10-15 in modern fighter and bomber aircraft. In the case of the ballistic missile, savings in the weight of structure, powerplant and tankage were even more important, since the objective was to give the missile the maximum kinetic energy and hence the longest ballistic range, and these weights determined directly the final acceleration imparted to the end stage. The tremendous premium attaching to reduction of these weights was shown in the diagram (Fig. 2). If W_0 was the all-up weight at the start of the flight and W_1 the residual weight when all fuel is consumed, ballistic missiles could expect to achieve a W_0/W_1 ratio of 20 or so, while the long-range aircraft was doing well to achieve a value of 2. In the missile case the range was proportional to the square of the logarithmic weight function, whereas in the case of the aeroplane it was directly proportional to it.

The development cycle of missiles and of aircraft (see outline below) was the next topic discussed by Mr. Serby. A prototype aircraft needed to be complete as a flying machine before its first flight, whereas with missiles each individual element (such as propulsion, drag, control, guidance) could be tested separately one by one, and only when each was satisfactory did the whole system need to be "buttoned together." Including test vehicles for individual tests, not necessarily of the same form as the final prototypes, approximately 200 missiles had to be flown in the course of the development of one type; for aircraft development between two and six prototypes would serve. This followed from the fact that missiles normally made one flight only.

DEVELOPMENT CYCLE

Aircraft	Missile
Choice of layout, W/S, powerplant, etc.; type of controls, flaps, etc.	Choice of guidance system in relation to warhead and fuse; choice of layout, powerplant, etc., in light of above.
Wind tunnel model work.	Wind tunnel model work together with ground launched models (rocket-propelled).
Scaled flying models.	——
Flying test-beds to prove powerplants, etc.	Propulsion rounds provided simply to develop boosts and sustainer. Test vehicles to develop powerplants, explore aerodynamics, boost separation, etc.
Prototypes 2-6.	R. and D. rounds 100-200.
A. and A.E.E. testing.	Acceptance rounds 50-200.
Production.	Production.

Missile development simply could not proceed without telemetry. The total flight-time available for the collection of data might be only ten seconds, during which time information about the propulsion, aerodynamics, and guidance and control responses to a variety of naturally evolved or commanded manœuvres might all have to be signalled back to the ground. Parameters to be examined varied from transient phenomena such as wing flutter, which required continuous channel recording, through combustion chamber pressures requiring less frequent sampling, to lateral and longitudinal g measurements, angular yaw, pitch or roll and voltage readings, which required only infrequent sampling.

Reliability was coming to be one of the most debatable characteristics of military equipment in general and of guided weapons in particular. It should be remembered that the overall reliability of a complex equipment was not the *average*, but was the *product*, of the individual reliabilities of its components. If, for example, an equipment had 100 components, each with a reliability of 99 per cent, the overall reliability would be about 35 per cent. To achieve 80 per cent overall reliability in a 400-component equipment, each item should have a failure rate of only one in 1,200—a figure that was high but surely attainable.

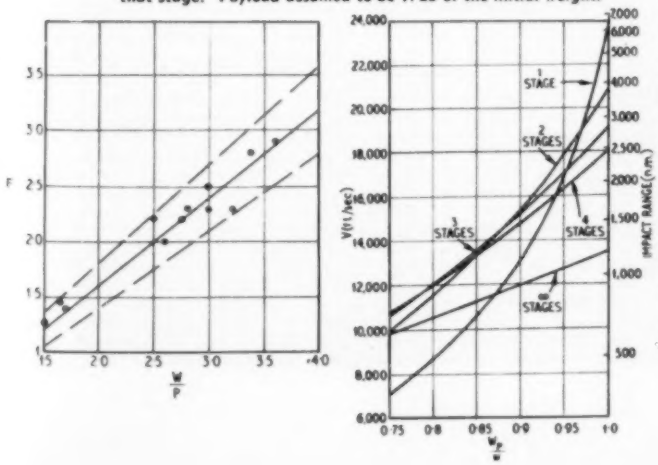
Although the aeroplane was highly complex, it could survive the failure of quite a few of its complex components—due partly to alternative or standby equipments and a human pilot to operate them. The picture changed as automatic devices took over more and more duties, however, particularly in the case of military aircraft, where target recognition, target seeking, bomb-aiming and even stability were relying more and more on electronics. In other words the military aircraft was coming more in line with the g.w. where, in general, failure of one component would prevent a successful mission.

Dealing with the subject of the techniques of missile recovery, the lecturer disclosed that the Weapons Research Establishment at Woomera, South Australia, was working on a system designed to recover missiles in flight. If this were successful, and it had reached this stage for small vehicles, there were wide possibilities for re-use.

In conclusion, Mr. Serby said that g.w. design had much to learn from aeroplane design and *vice versa*. The time was ripe for a greater sharing of experience.

Fig. 1 (left). Weight growth factor for 12 types of missile. Growth factor F plotted against total-weight/payload ratio. Mean line gives F=0.8 W/P; limit lines (dotted) give F=0.9W/P and 0.7W/P.

Fig. 2. Variation of all-burnt velocity V and range with W_p/W, where W_p=weight of usable propellent on any stage, and W=total weight of that stage. Payload assumed to be 1/25 of the initial weight.



DOPPLER IN OPERATION

Military Experience and Civil Prospects

A SERIES of papers on Doppler navigation read at the recent meeting of the Institute of Navigation included one of the first reports on R.A.F. experience with the equipment they have been using for the last three years. The Service may, in fact, have a greater operational background in the use of this equipment than either the Americans or the Russians. F/L. C. N. Moorhen of the R.A.F. Flying College told of the results.

Mr. G. E. Back of Marconi and Mr. J. I. Archibald of Decca Radar gave accounts of the equipment produced by their respective companies, units which were described in *Flight* respectively on July 12 and August 23. Mr. P. A. Houghton, of Marconi, discussed future applications and Mr. D. O. Fraser, of English Electric, a new entrant in the Doppler field, outlined the civil applications.

F/L. MOORHEN pointed out that Doppler had its limitations and that it had to be considered together with all the other elements in the navigation process. One of the primary limitations was the relative inaccuracy of present compass systems, both in performance and in maintenance. This was directly reflected in the results produced. A one-degree error in compass heading caused a 20 n.m. (1.67 per cent) position-error after 1,200 n.m. Compass calibration, setting of variation and deviation and monitoring by external fixing aids could help to reduce these errors.

At R.A.F. bases special sterile areas, accurately surveyed for compass swinging, were reserved. Local variation was known to within 0.5 deg and residual compass errors were reduced to a minimum and accurately known. Highly accurate A.C. and D.C. current was specially supplied and a datum compass of the theodolite type was used in order to bring all coefficients to less than 0.5 deg. The pilot himself would not be able to make use of such accuracy, but the Doppler equipment would. Hourly astronomical heading checks provided variation readings in flight. The complete Doppler system should then provide position information accurate to within ±1.7 to 2.0 per cent, equal to 17 to 20 n.m. after 1,000 n.m. Accurate check fixes would reduce these errors. Proper alignment of the aerial within the aircraft was important.

Despite the average errors quoted above, much better results had been obtained. Complete along-track accuracy and an average across-track error of 1.1 n.m. had been noted during a recent series of 300 n.m. flights at 1,500ft. With normal in-flight resetting during a series of 1,000-mile flights at 40,000ft average along- and across-track errors were respectively 3.7 and 4.86 n.m. Along- and across-track errors during climbs and descents to and from 40,000ft, each covering 50 to 80 miles, were respectively 1.09 and 1.25 n.m.

Considering further possibilities, F/L. Moorhen suggested autopilot steering signals, directional gyros, indication of rate of closing or departing from pre-set tracks and a flight log-type presentation of both position and track-made-good as possible features of future equipments. Particular operational advantages of Doppler were that it greatly reduced the navigator's routine work load, that it might allow a reduction in navigational fuel reserves, in A.T.C. traffic separations and the number of aids carried by an aircraft. It might also prove a very useful adjunct in broadcasting instant fixes when an emergency arose. Reliability of Dopplers in Service use had proved to be about 95 per cent for the Doppler alone and 77 per cent for the Doppler/computer/compass combination.

MR. HOUGHTON outlined some of the computer results and techniques now being considered for civil equipment. The airlines, he said, had expressed interest in the basic Doppler system, but were reserving their judgment on the computers until their exact requirements and the expense involved became clearer. Much depended on the user's operating range, area and traffic control requirements. The new equipment provided a means of continuous instead of instantaneous fixing, accurate wind-finding and efficient flight management. For traffic control purposes it allowed more accurate E.T.A.s.

Air position-indicators generally used with Doppler could not compute position at latitudes higher than 70 deg, but developments might go to 80 deg. Other computers could be arranged to integrate velocity through the polar region and, though losing position-indication near the pole, regain it on the other side. Indications in latitude and longitude were useful because they could be used to correct directional gyro indications and facilitate the flying of true Great Circle courses. Astro fixes could also be directly inserted, but the computers were expensive. Grid indications were more simple, but did not help gyro correction. Latitude calculation in the computer, with a low degree of accuracy, would nevertheless allow gyro correction accurate to 0.5 deg/hr.

Storage systems using cylindrical cams could be used for grivation and variation calculations; and these might, in a simplified computer, refer only to a relatively narrow area. Larger data-stores might hold a complete flight-plan. Great Circles could be flown with a north-seeking heading reference, or grid bearings could be converted to true. Punched cards could also be applied.

MR. HOUGHTON discussed indicators for showing track- or heading-error and others showing lateral displacement to facilitate regaining the original track. Such indicators were useful near the poles, where heading changed rapidly but the aircraft did not necessarily turn. Pictorial displays showing grid co-ordinates, grid tracks, great circles or rhumb lines were also mentioned.

The speaker pointed out the short-term usefulness of either drift and groundspeed or wind velocity memory systems, when winds were liable to change after the Doppler signal was lost for some reason. The second type of memory was more useful when course changes were made soon after loss of Doppler input. Wind velocity indications were most useful when observing wind changes and checking progress, E.T.A.s, finding jet streams and for giving precise wind information to the meteorologists. A computer giving latitude/longitude position, automatic track guidance, wind velocity and autovariation would require a ½ATR case and weigh 40 lb. The display would have a maximum depth of 6in and, with a heading reference accuracy of ±½ deg, the 95 per cent probability along- and across-track errors would not exceed one per cent. With ±1 deg heading error, accuracy would be 1.8 per cent. A directional gyro was attractive as an alternative to magnetic north-seeking systems, especially since it could be corrected by the computer which would also give compensation for Coriolis acceleration.

MR. D. O. FRASER thought that the influence of Doppler on civil aviation could only be guessed at at the moment, but it could certainly prove most useful in the areas where ground-based aids were few or non-existent. Doppler would fill these gaps; and it would also present easily-assimilated information to the pilot. Left/right pointers, autopilot couplers and position indications in simple rectilinear co-ordinates were examples of this.

In addition to mentioning the use of Doppler in calculating E.T.A.s and finding jet streams and other winds, Mr. Fraser suggested its usefulness in assisting cruise control and for proving flights. He also elaborated on the most important subject of three-dimensional route control for climb and descent. Very-low-drift directional gyros with drift rates of 0.1 deg/hr or 0.01 deg/hr were attractive as heading references, even in the lower latitudes, though suitable methods of aligning, warming up and calibrating such gyros in civil operations would have to be evolved.

Mr. Fraser thought that in low-density areas Doppler could provide guidance to the terminal navigation aid, while in high-density areas ground-based aids would be used to monitor and reset it. Monitoring fixes could be taken at times when the navigator was not busy, and with equipment not specially designed for pilot operation. Doppler would provide accurate information when the crew were more busy in the terminal area during let-downs or climbs, or despite frequent course and height alteration. Finding the I.L.S. centre-line without surveillance radar or going round again would be greatly simplified.

Mr. Fraser felt that aircraft longitudinal separation could be reduced when Doppler was available, particularly down to ten minutes over the Atlantic. The stepped descent or climb would be difficult for the big jets; and Doppler combined with an altimeter could provide accurate sloping flight paths. D.M.E. was used in this way during trials in Australia some years ago. Finally, Mr. Fraser asked whether Doppler might not be considered as the pilot's primary navigation aid, with other, non-pilot-interpreted systems for monitoring.

U.K. DOPPLER KNOWLEDGE FOR U.S.A.

IT was announced last week that the Radio Corporation of America has arranged to acquire technical information on the latest Doppler navigation equipment from Marconi's Wireless Telegraph Co., Ltd. The arrangement, it is stated, has been made "in the light of the Marconi Company's long experience in the design, development and flight tests of Doppler air navigational aids; R.C.A. is adapting and utilizing the Marconi technical know-how in the design of an R.C.A. equipment for use in civil airlines."

Marconi have been in quantity production of Doppler equipments for the R.A.F. during the past three years, while an entirely new design for use in civil aircraft was announced five months ago (see *Flight*, June 21). This, the Type AD2300, was first flown in experimental form in 1956, and flight trials of fully-engineered prototypes are at present taking place. Equipments may be available to airlines for flight evaluation early in 1958.

The Sopwith Tabloid, Schneider and Baby

HISTORIC MILITARY AIRCRAFT No. 17

PART IV By J. M. BRUCE, M.A.

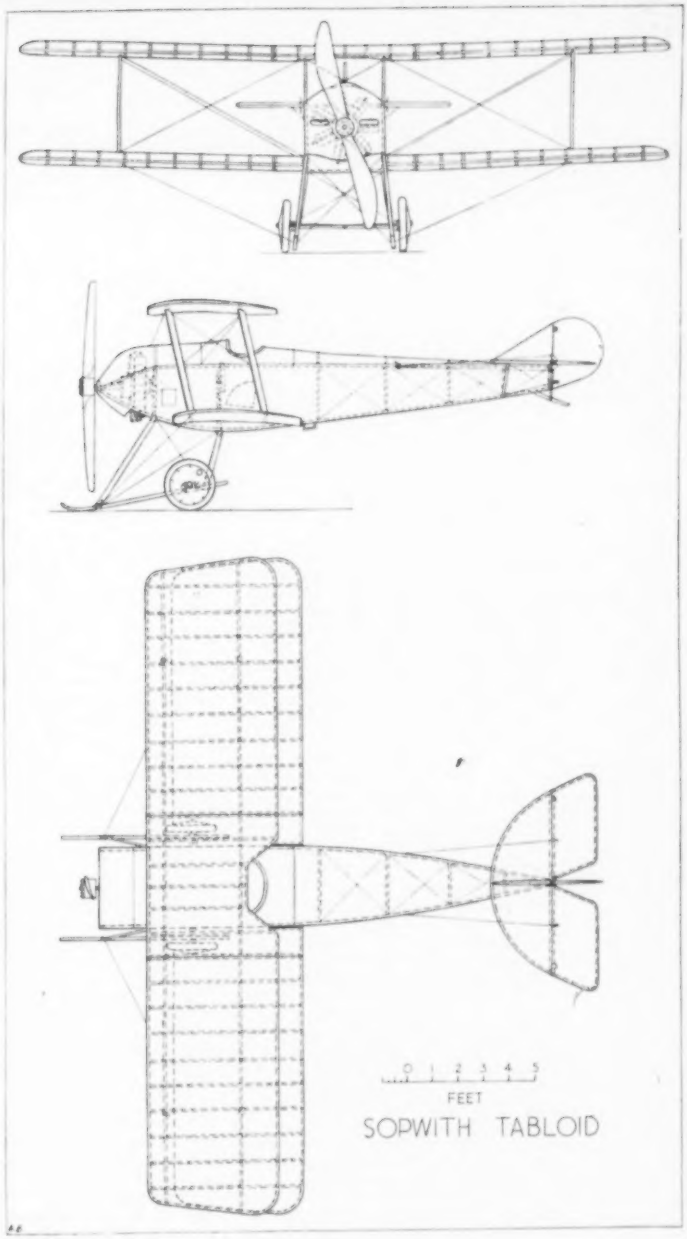
THE 130 h.p. Blackburn-built Babies of the batch numbered N.1410-N.1449 were intended for anti-Zeppelin duties. As originally delivered, they had no machine-guns, but were fitted with canisters (presumably within the fuselage) for Ranken Darts. Each container held 24 darts, which could be released three at a time. The Ranken Dart was a missile which had to be released from a point above the target. Its body was pointed and contained an incendiary composition; it had a tail consisting of four vanes designed to catch in the airship's fabric after the head had penetrated it. As these caught they jerked the spindle on which they were mounted; that in turn rubbed a match strip which ignited the incendiary charge. The Ranken Darts, although widely issued, were not successful, and some at least of the 40 Babies were given machine-guns: N.1437 had a synchronized Lewis gun mounted centrally above the fuselage, and a bomb rack was fitted underneath, just behind a fairing which might have housed the Ranken Dart containers. Likewise, N.1413 was used with a bomb rack under its fuselage, and a photograph shows the machine with a 65-lb bomb in place.

The fitting of the 130 h.p. Clerget produced the ultimate in Baby overloading: a few Blackburn-built machines had two Lewis guns—one fixed, the other in the original centre-section position—and the customary load of bombs.

Blackburn-built Babies and Hamble Babies were distributed to coastal stations on much the same scale as their predecessors; they also served with a number of carrier vessels. In only a few cases have they been specifically identified in the narratives of the war. One such instance was the attempted attack on the German cruiser *Goeben* on January 20, 1918, made by two bomb-carrying Blackburn-built Babies escorted by a Camel. The three British machines were attacked by ten enemy seaplanes. Capt. A. Moraitinis, the Greek pilot of the Camel, shot down three of the enemy, but Flt. Sub-Lt. W. Johnston's Baby fell in flames. Flt. Sub-Lt. R. W. Peel, flying the other Baby, pressed home his attack, but both his 65-lb bombs missed the *Goeben*. A refractory—possibly damaged—engine brought him down to the water, but he contrived to coax enough power out of it to enable him to taxi and fly in brief hops round Cape Helles and back to Imbros.

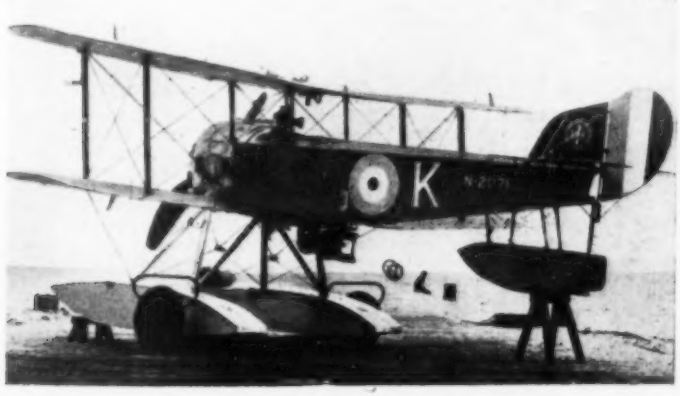
On November 2, 1917, the seaplanes on board the carrier *Empress* were two Hamble Babies (N.1209 and N.1210) and four Blackburn-built Sopwith Babies (N.1028, N.1036, N.1038 and N.1129). On that day three of the carrier's seaplanes bombed the railway bridge at Jaljulye with 65-lb bombs; after their return, *Empress* steamed north to Haifa, and a further raid was made, this time on an oil factory near the port. Two of the Babies were forced down in Haifa Bay and were lost; their pilots were rescued by the *Coutelas*, a French destroyer.

Baby seaplanes of all makes served with the Adriatic, Aegean and Egypt Groups in 1918; they operated from such bases as Otranto, Santa Maria di Leuca, Imbros, Mudros, Suda Bay and Syra. They were never very numerous: by the end of August 1918 the Aegean Group had only eight serviceable Baby seaplanes, and late in 1918 there remained a total of 30 in the Mediterranean area. Several were lost while *en route* to the Mediterranean when the merchantmen in which they were being transported were sunk by enemy action.



In home waters the Babies went about their routine affairs, patiently and unobtrusively, until the Armistice brought them respite. They had their moments of action, too; as, for instance, on September 23, 1916, when F/L. C. J. Galpin of Great Yarmouth air station attacked a Zeppelin 30 miles east of Lowestoft. He was flying a Schneider or Baby, and succeeded in firing a full drum of explosive ammunition into the airship; he claimed that some of his bullets struck the gondolas, but his attack failed to ignite the Zeppelin and he was compelled to break off the engagement owing to darkness.

On June 16, 1917, F/L. G. H. Bittles, also of Great Yarmouth, attacked an enemy airship in the same area. Bittles coaxed his Sopwith up to 11,000ft and opened fire. Like Galpin, he emptied



Blackburn-built Baby, with two Lewis guns and—attached beneath the fuselage—one 65 lb bomb.

The Sopwith Tabloid, Schneider and Baby . . .

a full drum into the Zeppelin, but it failed to catch fire and climbed away rapidly out of reach of the little seaplane.

One of the anti-submarine Babies bombed a U-boat on May 30, 1918, but failed to destroy it; the submarine had previously been attacked by a D.H.6. The Baby pilot fired light signals, which attracted a destroyer and a Blackburn Kangaroo, but the U-boat had vanished. It was sunk next day, however, thanks partly to the efforts of an F.E.2b from Seaton Carew.

The final production variant of the basic Sopwith design had a wheel undercarriage. It was a landplane version of the Hamble Baby, in which twin skids replaced the floats and carried a cross-axle with landing wheels. The original float struts and cross-bars were retained; consequently the undercarriage was of unusually wide track. The aircraft was known as the Hamble Baby Convert.

The first aircraft to have its floats replaced by wheels was the Fairey-built Hamble Baby N.1321. All production Hamble Baby Converts were built by Parnall, however; the last 74 machines of Parnall's second contract were Converts.

It seems probable that the Hamble Baby Converts were intended for service as deck-flying single-seat fighters, but it is doubtful whether any saw operational service in that capacity. By the time the Converts were coming into service, the Sopwith Pup was available with a much better performance and superior handling qualities. Some of the Converts were used at training stations, but the variant never became widely known and was in fact declared obsolete three months before the Armistice.

Some months before the first Hamble Baby was produced by rebuilding No. 8134, another Sopwith Baby had been modified with a view to increasing its lifting capacity. The scene of the experiments was the R.N.A.S. station, Port Victoria, where the Marine Experimental Aircraft Depot was situated.

That unit had its origin in the R.N. Aeroplane Repair Depot which was commissioned early in 1915 under Sqn. Cdr. G. W. S. Aldwell. It was housed at the Isle of Grain in a building which had formerly been the Salvation Army Congress Hall in Kingsway, London; the hall had been taken to Grain in pieces and re-assembled there, within a few hundred yards of the original Isle of Grain seaplane station. The new station was named Port Victoria to distinguish it from the old, but as the war progressed the new unit far outgrew the Isle of Grain station until the Marine Experimental Aircraft Depot was set up, with its three sections: the Experimental Construction Depot, the Seaplane Test Depot, and the Experimental Armament Section.

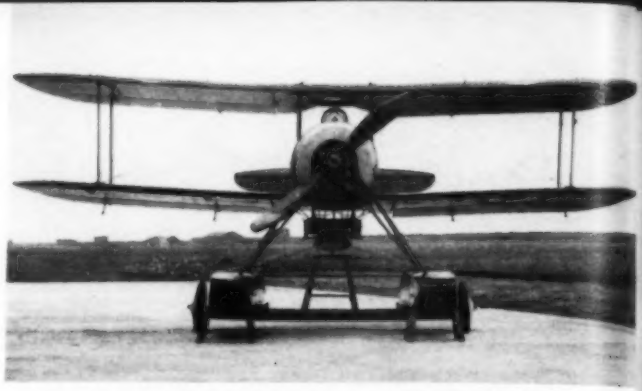
The officer commanding the original Isle of Grain seaplane station when it was commissioned in December 1912 was Lt. J. W. Seddon, R.N. As a squadron commander he was still at Grain in 1916. Early that year he read reports of National Physical Laboratory experiments with heavily-cambered aerofoils. The results clearly indicated that such aerofoils gave much more lift than the widely-used contemporary thin aerofoils. Seddon was aware of the limitations of the Sopwith Baby seaplane and of the possible consequences of persistently overloading it. He was convinced that the Baby could lift its load with much greater ease if it were fitted with wings of high-lift section, although it was realized that the aircraft's speed would be reduced.

It was decided, as an experiment, to fit a Baby with high-lift wings; the work was undertaken by the Experimental Construction Depot. Tht new wings had the same area as the original Baby mainplanes, but had a higher aspect ratio and were rigged with a pronounced stagger; they were, of course, heavily cambered. The experiments were pursued with great speed and to the exclusion of such considerations as weight saving. The wings were attached in the position which gave the pilot the best view from the cockpit, and the heavy stagger placed the lower wings farther aft than those of the original Baby. The spars of the lower centre section were therefore sawn off flush and left in the fuselage, thereby facilitating the attachment of the new mainplanes. The centre of gravity was adjusted by placing lead in the floats, which were new and somewhat larger than standard.

The product of this reconstruction was designated Port Victoria P.V.1, and was quite 300 lb heavier than a standard Sopwith Baby. Nevertheless, with a further 300 lb of lead aboard, the P.V.1 climbed to over 8,000ft, and was reported to be responsive to the controls. Thus, in its climbing performance, P.V.1 fulfilled Sqn. Cdr. Seddon's expectations. The level speed suffered considerably, but at 67 kt (77 m.p.h.) was little worse than had been expected.

The P.V.1 was flown at Port Victoria for some time, and was later used in preliminary experiments designed to investigate the problems associated with the catapulting of aircraft. As one of the experiments, the P.V.1 was flown off a railway truck in the sidings at Grain.

By the time Sqn. Cdr. Seddon's belief in the high-lift aerofoil had been vindicated by the P.V.1, the Fairey Hamble Baby was in prospect and was considered likely to be capable of meeting all known Service requirements. Consequently, the P.V.1 was not developed further, but it is of considerable interest as the forerunner of several excellent single-seat seaplanes which were built at Grain, some of which might with advantage have replaced the Baby.



Fairey Hamble Baby with two 65 lb bombs. This view clearly shows the patented variable-camber flaps.

A purely Sopwith development of the Schneider/Baby type was the Sopwith FS.1. It is doubtful whether the design progressed beyond the project stage, but it was for a seaplane with greater dihedral on the lower wing than on the upper, a vertical tail which resembled that of the Pup, and a 130 h.p. Clerget engine; its armament was to be a fixed Vickers gun on the fuselage and a Lewis above the centre section. Span was 27ft, length 21ft 6in.

A considerable number of Schneiders and Babies were transferred to the governments of other countries. Four Schneiders (3707, 3709, 3765 and 3806) and four Babies (8125, 8197, 8204 and 8209) went to Canada; some of them were veterans of the R.N.A.S. before their transfer, and all were sent without engines, for these were scarce. France received four Babies (8128, 8129, 8185 and N.1106) and Italy two (8214 and 8215).

The two last-named machines are reported to have been sent to Italy in mid-August 1916 as patterns for production of the Baby in Italy. It seems doubtful whether production was undertaken in that country, however; certainly, if any Sopwith Baby seaplanes were built there, it appears even more doubtful that they were ever used by the Italian naval aviation service. Describing Italian naval equipment of 1917 in his book, *L'aviazione austro-ungarica sulla fronte italiana*, 1915-18, Riccardo Cavigioli wrote:

"Naval aviation was equipped basically with the F.B.A. and L.3 [an Italian copy of the Austrian Lohner flying-boat], to which was added the S 8, an improved version of the F.B.A. powered by a 160 h.p. Isotta Fraschini V4B. The Macchi company of Varese produced a hydro-aeroplane of Italian design, the M 4, a two-seat biplane flying-boat which had a 300 h.p. Fiat and was capable of 170 km/hr; it was designed for reconnaissance and bombing duties. Towards the end of 1917 the same firm built the M 8, another two-seat biplane flying-boat with a 160 h.p. engine; its speed was 165 km/hr.

"These machines performed the multiple duties of fighting, reconnaissance and bombing."

Writing of the Italian sea-going aircraft of 1918, Cavigioli recorded these further notes, which leave little doubt that the Italian naval aviators had no single-seat fighting seaplanes before the introduction of the Macchi M 5 and its successor the M 7:

"At sea, our hydro-aeroplanes held high the name of Italy, attacking the heavily defended enemy coast whenever the weather permitted. In the early months of 1918, Italian naval aviation had its own fighter, the M 5: this sturdy, agile little machine was fully aerobatic and had a speed of 185 km/hr. . . . Towards the end of the war the M 7 [was built], a fighter flying-boat designed from the experience gained with the M 5; the later type, which had a 250 h.p. Isotta Fraschini V6 and a speed of 210 km/hr, was faster and more manœuvrable than the M 5, but was not effectively used during the war."

Japan had at least one Schneider, and Baby No. 8201 was also sent there, engineless.

A few Schneiders and Babies were bought by America; they were apparently used by U.S. naval aviators in the European theatre of war, for they were marked with American roundels. One of the Schneiders had a four-bladed propeller, and at least one of the Babies was Blackburn-built; it bore the serial number N.3709 on its fuselage, painted in the place and style of the serials of standard R.N.A.S. Babies.

In 1918 the Norwegian government bought 12 Blackburn-built Babies for the use of the Norwegian Naval Flying Service; a few Norwegian naval officers had undergone a training course at a British seaplane station. These aircraft could have float, wheel or ski undercarriages. When wheels or skis were fitted, they were attached to neat, simple vees and had a normal track: no attempt was made to retain the original float N-struts and cross-bars as on the Hamble Baby Convert. On the Norwegian machines the tail-skid was fitted to the long shaft which normally actuated the water rudder, and the rear tail-float attachment struts were retained.

These Norwegian machines remained in service for several years. In 1923 Capt. Amundsen, the great explorer, led an expedition into Arctic regions, and with him he took the Sopwith Baby F.108, which operated from Spitsbergen.

It therefore seems probable that the Baby, as a type, last served in Norway, for all Sopwith and Blackburn-built Babies in British service were withdrawn and scrapped soon after the Armistice. They had been preceded by the Hamble Baby Converts, which had been declared obsolete on August 2, 1918. The Hamble Baby seaplanes were not declared obsolete until August 7, 1919, but it is highly doubtful whether many were still active at that date.

The final word is (as usual) best left to one of the pilots who knew and flew the little Sopwith seaplanes. The following passage* relates to the situation in the spring of 1918, and it is interesting to note that the officer concerned uses only the name Schneider, although it is obvious that the aircraft to which he refers were much more probably Babies. His remarks are best quoted in full, for they describe authentically the multifarious duties of the Sopwiths, their qualities and capabilities. Of the Schneider Flight of the R.N.A.S. station, Great Yarmouth, he said that it consisted of

". . . two or three old Schneiders, patched and warped and bone-rattling, which were used for any job going. . . . The machine was naturally a little difficult (sensitive and light) to take off and land, especially on the troubled seas which were commonly encountered at Yarmouth. There was the danger of smashed airscrews before getting up speed; the danger of turning turtle on gaining speed and alighting. One was always drenched with spray. They were good machines in the air, but with bombs and other gear it was unwise to load them too much. They had no sights for bombing, but a Lewis machine-gun firing through the airscrew, and one also on the top plane. A carrier pigeon, fresh water, and sea anchor were carried as well.

"The duties of the Schneider flight were extraordinary in their variety.

Types of Patrols

"1. Hostile aircraft patrol. Yarmouth War Channel to Orfordness, to try to catch hostile torpedo-carrying seaplanes. 2. Hostile submarine and aircraft patrol to Smith's Knoll light vessel and War Channel area. 3. Hostile submarine and aircraft patrol to Haisborough light vessel *via* other light vessels—Newarp, for example. 4. Hostile submarine and aircraft patrol to Cross Sands area. 5. Hostile aircraft patrol to Shipwash area with two Camels. 6. Hostile aircraft patrol with two Camels and Short seaplane to Smith's Knoll. 7. Hostile aircraft patrol to Smith's Knoll and Shipwash with one flying-boat. 8. 'Decoy' patrol to Smith's Knoll—Camels. (Three Schneiders left before the Camels and circled round the Knoll till the Camels came; after a while returned. The decoy did not work.)

Special Patrols

"1. Escorting the mine-layer (H.M.S. *Princess Margaret*). 2. To North Hinder light vessel with flying-boat and Camels. 3. German fleet 'scare' patrols. 4. Patrols to various points at which submarines and mines were reported. 5. Special emergency patrols, e.g., for missing machines. 6. Anti-Zeppelin patrols, one of which consisted of two flying-boats, three D.H.4s, three Camels, one Short, and two Schneiders.

"It was the machine for the lover of solitude and independence and a wandering kind of life. The Schneider was a sort of detective, exposing all mysteries, such as whales mistaken for submarines, streaks of oil, and rescuing colleagues in difficulties. Any wild rumour—out went the Schneider to investigate. They were the Police Force of the Yarmouth Patrol.

"The question is often asked—how would a Schneider, in the hands of a seasoned Schneider pilot, have fared in a scrap with a German seaplane? The Schneider had no sensational accomplishments to its name at Yarmouth, probably because of the amazing way in which it escaped actual contact with the enemy. Perhaps the lonely forager was often seen—unknown to himself—but left alone because of sympathy or fear! Schneider patrols usually lasted from one and a half to two hours. The height at which the patrols were made was comparatively low, for experience went to show that small objects, such as periscopes, could not be detected from an enclosed machine like the Schneider from greater altitudes, and detection from above of a low-flying Schneider was extremely difficult."

* From *The Story of a North Sea Air Station*, pages 369-370.

The Yarmouth Schneiders were not, of course, unique, for the Schneiders, Babies and Hamble Babies had no truly sensational accomplishments to their name anywhere. They had had their early failures; they had plodded stolidly on, although several superior types of marine single-seat fighters were designed during the war years and ought to have supplanted them; and they had reached the Armistice still operational. That, perhaps, was their most remarkable achievement: so routine and unspectacular were their duties that it is not always remembered that their basic design was completed in 1913.

SPECIFICATION AND SUMMARY

Powerplants

Tabloid.—80 h.p. Gnôme, 100 h.p. Gnôme Monosoupape.
Schneider.—100 h.p. Gnôme Monosoupape.
Baby.—110 h.p. Clerget, 130 h.p. Clerget.
Hamble Baby.—110 h.p. Clerget, 130 h.p. Clerget.

Manufacturers: *Tabloid.*—Sopwith Aviation Co., Ltd., Canbury Park Road, Kingston-on-Thames. **Baby.**—Sopwith Aviation Co., Ltd.; Blackburn Aeroplane and Motor Co., Ltd., Olympia, Leeds. **Hamble Baby.**—Fairey Aviation Co., Ltd., Hayes, Middlesex, and at Hamble Point; Parnall and Sons, Mivart Street, Eastville, Bristol.

Production and Allocation: *Tabloid.*—At least six were built before the war, and about 36 were produced between October 1, 1914, and June 30, 1915. Four went to France in 1914, one in 1915; four were sent to training units in 1914 and one in 1915; at least four were allocated to the R.N.A.S. unit commanded by Cdr. Samson; and two were taken to the Dardanelles aboard H.M.S. *Ark Royal*.

Schneider.—One hundred and thirty-six were built.

Baby.—At least 286 were built. By October 31, 1918, only 58 remained on charge with the R.A.F.: of these, 21 were in the Mediterranean, three were attached to the Grand Fleet, and 34 were at seaplane stations in the United Kingdom.

Hamble Baby.—A total of 180 were constructed, 50 by Fairey and 130 by Parnall. Seventy-four of the Parnall-built machines were landplane Converts. Eighteen Hamble Babies were on charge on October 31, 1918; nine at home stations and nine in the Mediterranean.

Armament: *Tabloid.*—Various makeshift arrangements of pistols, carbines and (ultimately) a single Lewis machine-gun mounted either above the centre section or on the starboard side of the fuselage firing forward through the armoured propeller. A small load of 20-lb bombs could be carried.

Schneider.—One Lewis gun mounted in the centre section to fire forward and upwards at a shallow angle over the propeller, or mounted just in front of the cockpit, firing nearly vertically upwards through the aperture in the centre section; one 65-lb bomb or up to five 20-lb bombs.

Baby and Hamble Baby.—The standard weapon was a single Lewis gun, mounted either in the centre section or fixed on top of the fuselage and synchronized to fire through the propeller. Some experimental variations are described in the foregoing narrative. A few Babies had twin Lewis guns above the centre-section, and some late Blackburn-built machines had both the fixed Lewis gun on the fuselage and one in the centre section. A number of Blackburn-built Babies were equipped to carry containers of Ranken Darts, and at least one machine was fitted with ten Le Prieur rockets. The standard bomb load consisted of two 65-lb bombs.

Service Use: *Tabloid.—Western Front:* R.F.C. Squadrons Nos. 3, 4 and 7; R.N.A.S. Eastchurch Sqn., Antwerp; No. 1 Sqn., R.N.A.S., Dunkerque. *Dardanelles:* H.M.S. *Ark Royal*; No. 3 Wing, R.N.A.S., Tenedos. *Home Stations:* No. 1 Sqn., R.N.A.S., Gosport; R.N.A.S. station, Great Yarmouth.

Schneider and Baby.—Seaplane stations at Calshot, Dundee, Dunkerque, Felixstowe, Fishguard, Great Yarmouth, Killingholme, Scapa Flow, Westgate. Aircraft carriers *Ark Royal, Ben-my-Chree, Engadine, Furious, City of Oxford, Peony, Riviera, Campania, Vindex, Anne, Raven II, Empress, Manxman.* Light cruisers *Arethusa, Doris, Undaunted.* Gunboat *Halcyon.* Paddle steamers *Brocklesby* and *Killingholme.* Steam trawlers *Kingfisher, Cantatrice.* Experimentally with H.M. Submarine *E.22. Mediterranean:* Seaplane stations at Otranto and Santa Maria di Leuca. *Aegean:* R.N.A.S. stations at Thasos, Suda Bay and Syra. *Egypt:* R.N.A.S. stations at Port Said and Alexandria.

Above, Parnall-built Hamble Baby.

Left, Parnall-built Hamble Baby Convert.

The Sopwith Tabloid, Schneider and Baby . . .

Schneiders and Babies were supplied in small numbers to Canada, America, and Japan; a few Babies went to France and Italy. Twelve Blackburn-built Babies were used by the Norwegian navy.

Hamble Baby.—Seaplane stations at Fishguard, Calshot, Killingholme, Lee-on-Solent, Cattewater. *Mediterranean:* Seaplane stations at Otranto and Santa Maria di Leuca; seaplane carrier *Empress*. *Aegean:* Seaplane stations at Suda Bay, Syra, Skyros and Talikna. *Egypt:* Seaplane stations at Port Said and Alexandria. *Training:* Hamble Baby Converts used at some R.N.A.S. aerodromes, e.g., Cranwell.

Serial Numbers: *Tabloid.*—123, 124, 167-169, 326, 394, 1201-1213. *Schneider.*—1436-1447, 1556-1579, 3707-3806.

Baby.—Sopwith-built: 8118-8217. Blackburn-built: N.300, N.1010-N.1039, N.1060-N.1069, N.1100-N.1129, N.1410-N.1449, N.2060-N.2134.

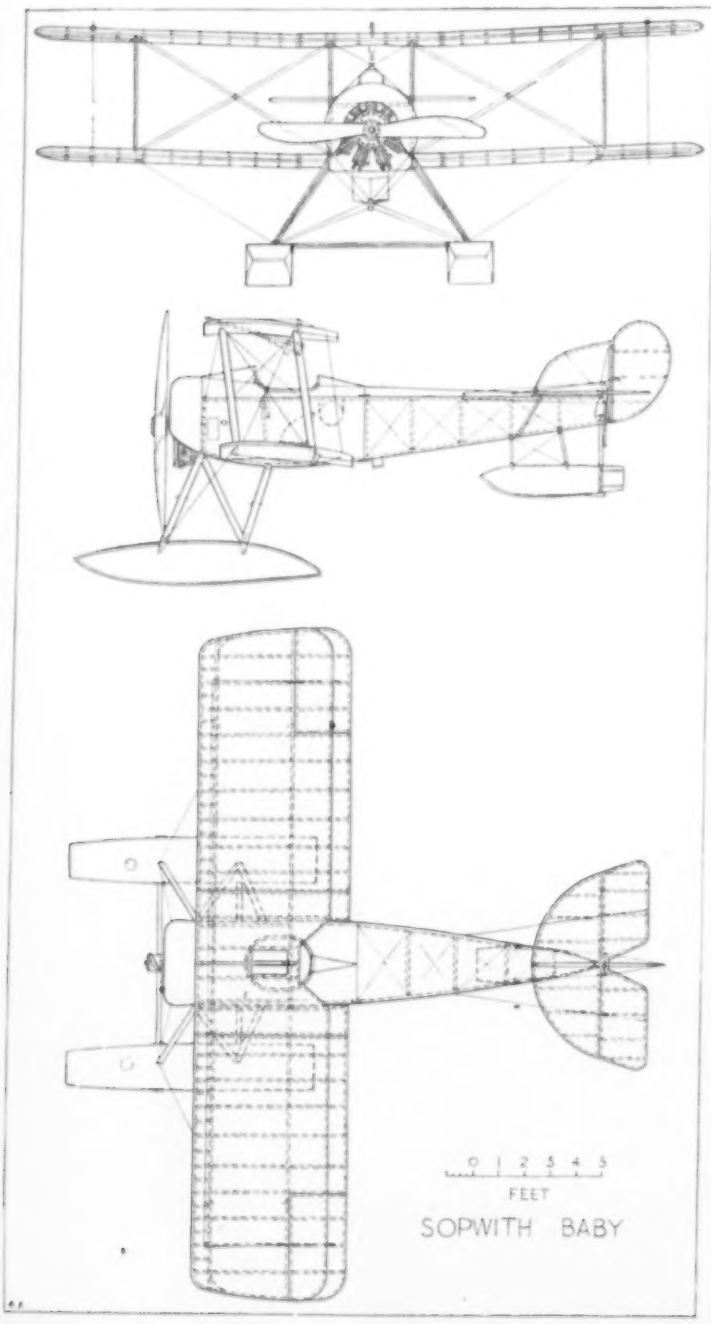
Hamble Baby.—Fairey-built: N.1320-N.1339, N.1450-N.1479. Parnall-built: N.1190-N.1219, N.1960-N.2059 (N.1986-N.2059 were Hamble Baby Converts).

Notes on Individual Machines: *Tabloid.*—167 and 168: R.N.A.S. squadron at Antwerp, October 1914; flown by Sqn. Cdr. Spenser D. A. Grey and F/L. R. L. G. Marix respectively, they bombed Cologne and Düsseldorf on October 8. 1208: R.N.A.S. station, Great Yarmouth. *Schneider.*—1436: R.N.A.S., Calshot, February 1915. 1437: to Eastern Mediterranean, March 1915. 1443: attached H.M.S. *Engadine* for anti-Zeppelin duties. 1445: lost in wreck of S.S. *Junga*. 1556: R.N.A.S., Calshot, April 1915. 1557: attached H.M.S. *Undaunted*. 1558: R.N.A.S., Great Yarmouth. 1559: to H.M.S. *Campania*. 1560 and 1561: *Ben-my-Chree*. 1563: *Campania*. 1566, 1577, 1578 and 1579: *Ark Royal*. 3707: *Campania*; later sent to Canada without engine. 3709: *Campania*; later to Canada without engine. 3711: *Engadine*. 3713: *Ark Royal*. 3721: *Ben-my-Chree*. 3722: *Ben-my-Chree*, damaged at Port Said, 17.4.16. 3727: *Ben-my-Chree*. 3736: Great Yarmouth. 3755: *Vindex*. 3765: to Canada without engine. 3772, 3773, 3774, 3775, 3787 and 3788: *Empress* (3773 damaged beyond repair, 16.3.17). 3796 and 3797: *Campania*. 3801: R.N.A.S. Killingholme. 3806: to Canada without engine.

Baby.—8120: to *Campania*, 29.10.15; written off 9.8.16. 8125: *Campania*, later to Canada without engine. 8128 and 8129: to French government, April 1916. 8134: to Fairey Aviation Co. for repair, 23.10.16; became prototype Hamble Baby; written off at Eastchurch, 9.6.17. 8135: damaged near El Arish, 17.9.16. 8138: lost 10 miles north of Ostend, 16.11.16. 8140: interned in Holland. 8142: wrecked at Scarborough, July 1916. 8143: *Vindex*, damaged in raid off Schleswig-Holstein, April 1916. 8152: *Vindex*, lost off Schleswig-Holstein, 25.3.16. 8155: lost in Humber, 21.4.16. 8158 and 8159: *Vindex*, lost off Schleswig-Holstein, 4.5.16. 8164: Great Yarmouth. 8180: *Engadine*. 8185: to French government without engine. 8194: issued from White City stores to Parnall and Sons, January 1917; wrecked at Calshot, October 1917. 8197: to Canada without engine. 8198: wrecked at Felixstowe, April 1917. 8201: to Japan without engine. 8204 and 8209: to Canada without engines. 8210: R.N.A.S. Calshot. 8214 and 8215: sold to Italy, August 1916. 8216 and 8217: to White City stores April 1916; dismantled there for spares, July 1917.

N.300: *Campania*, February 1917; written off at Scapa Flow, 11.5.18. N.1012: *Campania*. N.1013, N.1020, N.1021 and N.1022: *Manxman* (N.1020 lost, 14.2.17). N.1028: *Empress*, Port Said. N.1030: to Otranto; wrecked at Dover (H.M.S. *Riviera*), 28.6.17. N.1036 and N.1038: *Empress*, Port Said. N.1063: R.N.A.S. Dundee. N.1106: presented to French government with 110 h.p. Clerget. N.1117: wrecked at Mudros. N.1121: to a foreign government with 110 h.p. Clerget. N.1129: *Empress*, Port Said. N.1430 and N.1431: to a foreign government with 110 h.p. Clergets. N.2060, N.2061, N.2062, N.2065, N.2066, N.2067 and N.2070: scrapped at Killingholme, December 1917.

Hamble Baby.—N.1204: accepted from makers, 26.7.17; deteriorated beyond repair at Killingholme, 20.4.18. N.1209 and N.1210: *Empress*, Port Said. N.1321: became Hamble Baby Convert. N.1970: R.N.A.S. Lee-on-Solent. N.1972: R.N.A.S., Calshot. N.1980: lost in S.S. *Perier*, sunk, 29.12.17, bound for Otranto.



WEIGHTS AND PERFORMANCE

	Tabloid		Baby		Hamble Baby seaplane
	Prototype	Production	110 h.p. Clerget	130 h.p. Clerget	110 h.p. Clerget
Weight empty (lb)	670	730	—	1,226	1,386
Military load (lb)	—	—	—	255	365
Fuel and oil (lb)	—	—	—	234	195
Weight loaded (lb)	1,060	1,120	1,580	1,715	1,946
Max. speed (m.h.p.) at ground/sea level	92	—	92	100	—
2,000ft	—	—	—	—	90
6,500ft	—	—	—	—	90
Climb (min and sec) to:					
1,200ft	1 00	— —	— —	— —	— —
2,000ft	— —	— —	— —	— —	5 30
3,000ft	— —	— —	— —	— —	8 30
6,500ft	— —	— —	— —	— —	25 00
7,000ft	— —	— —	— —	— —	28 30
10,000ft	— —	— —	— —	35 00	— —
Service ceiling (ft)	—	—	—	—	7,600
Endurance (hr)	3½	—	—	2½	2

DIMENSIONS

	Tabloid		Schneider	Baby (130 h.p.)	Fairey Hamble Baby
	Prototype	Production			
Span	25ft 6in	25ft 6in	25ft 8in	25ft 8in	27ft 9½in
Length	20ft	20ft 4in	22ft 10in	23ft	23ft 4in
Height	—	8ft 5in	10ft	10ft	9ft 6in
Chord	5ft	5ft 1½in	5ft 2in	5ft 2in	4ft 9in
Gap	4ft 3in	4ft 6in	4ft 6in	4ft 6in	4ft 6in
Stagger	—	11in	8in	8in	—
Dihedral	—	1 deg 30 min	2 deg	2 deg	—
Incidence	—	1 deg	3 deg	3 deg	5 deg or 2 deg 30 min
Span of tail	9ft 6in	8ft 3in	8ft	9ft 5in	10ft 9in
Areas (sq ft)					
Wings	240	241.3	240	240	246
Tailplane	10	11.8	14	14	24
Elevators	12	11.8	12	12	17
Fin	Nil	1.875	2.7	2.7	4.3
Rudder	7	4.27	6.5	6.5	6.7

Footnote: Information supplied by Mr. Bruce Robertson and material lent by Mr. A. R. Weyl, A.F.R.Ae.S., A.F.I.A.S., F.B.I.S., has contributed substantially to this history, and the author wishes gratefully to acknowledge their assistance.

WHAT THEY SAY ABOUT THE GAZELLE

The new heli-jet is silent

By Daily Mail Air Correspondent

BRITAIN'S first production jet helicopter, the Westland Wessex, was demonstrated ... yesterday. ... He said its gas turbine Napier Gazelle gave Britain the lead in this type of engine. The plane has been ordered ... in quantity ... Royal Navy ...

... air trans... It flew upwards, downwards, backwards, turned, and even pranced like a horse. Westland's chief test pilot, ex-Fleet Air Arm Lieut. "Slim" Sear, said: "I had a new observer, and the engine was so quiet he thought it had stopped." He said its gas turbine Nap... gave Brit... of eng...

When the Westland "Wessex" flew at Yeovil last July 9th, the air correspondents of the National Press were unanimous in their praise of the aircraft and particularly of the engine powering it: the Napier free-turbine Gazelle.

ITS SILENCE External noise has been reduced by more than half compared with that of a piston-engined helicopter: an important step toward the reality of city-centre to city-centre air transport. Inside the cabin the engine is almost inaudible.

ITS TAKE-OFF The Wessex can take off in less than half a minute from engine start, and its rate of climb has been described as 'remarkable'. This is a valuable asset in emergency. In addition, the engine can be operated at 30% above its normal maximum power output for short periods.

ITS REVOLUTIONARY DESIGN **The Gazelle is eminently suitable for helicopter work because it is both light and tough. Without clutches, etc., the free-turbine arrangement takes pounds off the weight of the transmission mechanism. At the same time it is planned to give long service between overhauls and, because of the unique 'unit' method of construction, repair time is cut to a minimum.**

The Gazelle marks an epoch in helicopter design as significant as the change-over from piston to jet engine in fixed-wing aircraft. Everyone interested in the future of British aircraft should know about it. Write to D. Napier & Son Ltd. London, W.3 for more details.

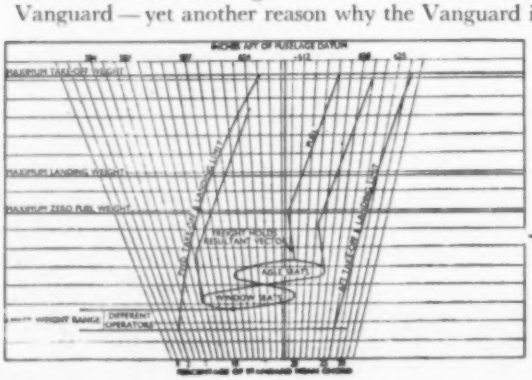
NAPIER GAZELLE FREE TURBINE ENGINE

CRC G8

All this FREIGHT from a PASSENGER aircraft?

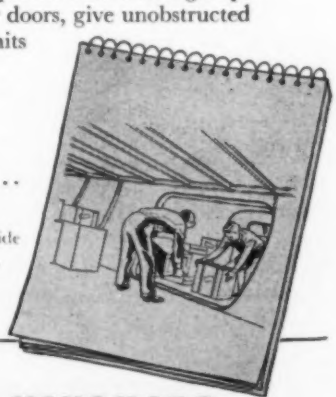
Yes, it's the VANGUARD

The ability to carry up to 120 passengers or ten tons of freight (density 15 lb. per cubic foot), will ensure profitable operation of the VANGUARD, winter and summer, day and night — even when passenger traffic is at its lowest ebb. With a combined capacity of 1,360 cubic feet, the two spacious holds in the 'double-deck' fuselage give ample room to arrange the freight conveniently in separate destination groups. The exceptionally wide freight doors, situated on the side opposite the passenger doors, give unobstructed access for simultaneous loading and unloading. The very wide C.G. range permits maximum flexibility of passenger and cargo loading. The 'loading loop' below shows the ideal matching of the C.G. limits which is possible with the Vanguard — yet another reason why the Vanguard is the airline's airliner.



For your notebook...

Each freight hold has an unobstructed access 5ft. 6in. wide and 3ft. 10in. projected height. Headroom inside is 4ft. 3in.



VICKERS VANGUARD

Four Rolls-Royce Tyne Propeller-Turbine Engines

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

TGA AT518A

CIVIL AVIATION

AN INDEPENDENT BUYS TWIN PIONEERS

THE first order for Twin Pioneers from a British independent operator is announced. The Airwork associate company, Fison-Airwork, who are best known for their industrial helicopter operations, have placed an order with Scottish Aviation for the delivery of two aircraft in early 1958.

Fison-Airwork will use their Twin Pioneers for oil-exploration activities in Nigeria, work which the company have been doing for four years on behalf of the Shell-B.P. Petroleum Development Company. So far Westland S-55 Whirlwind helicopters have been used to ferry engineers, drilling-rig crews and their equipment from head base across the Niger Delta (an area of swamp and jungle where landing sites are limited) to the drilling sites.

It is significant that a helicopter operator should have chosen the Twin Pioneer, whose STOL performance makes it "the ideal choice" (to quote Fison-Airwork) for their particular job.

A total of 23 Twin Pioneers have now been sold to 11 commercial operators, as follows: Austrian Government, 1; Borneo Airways, 2; British International Airlines (Kuwait), 2; De Kroonduif, 3; Fison-Airwork, 2; Philippine Air Lines, 5 (4 with Pratt and Whitney engines); Royal Iran Flying Club, 3; Rio Tinto Mining Company (Rhodesia), 1; T.A.E. (Spain), 3; Zinc Corporation of Australia, 1. In addition Scottish Aviation have a military version in quantity production for the R.A.F.

£1m. B.E.A. PROFIT COMING UP

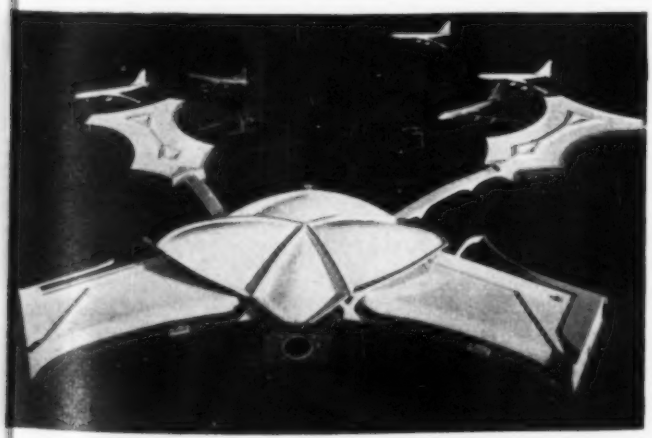
HAVING made a net profit during the six summer months of £3½m, the B.E.A. are now hoping to wind up their 1957-1958 accounts with a net profit of £1m. This will be the first time that the Corporation will have cleared a round million since they made their first profit in 1954-55 of £63,000.

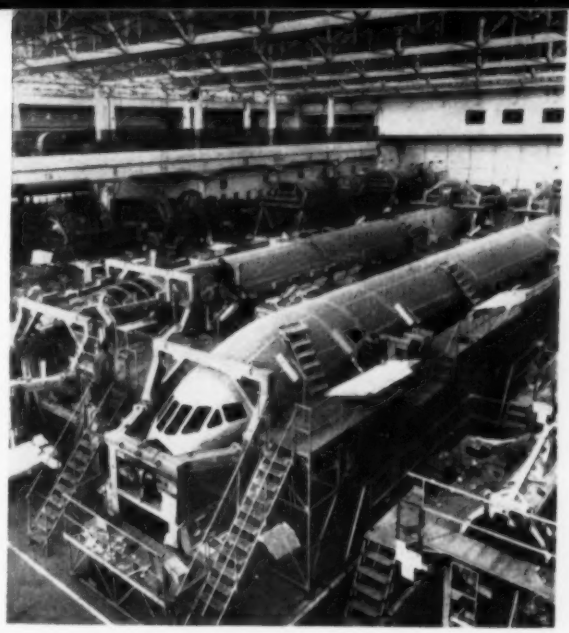
The six-month winter business "shortfall" is thus expected to be about £2½m. Most important achievement during the summer was a 66.7 per cent load factor, which was 1.4 per cent higher than in the previous summer. It is significant, too, that the extra staff taken on to cope with the summer peak traffic increased by only four per cent. The staff increase during the previous summer was 12 per cent.

AMERICAN RIGHTS INTO HONG KONG

AN American senator, Mr. Hubert A. Humphrey, has written a letter to President Eisenhower saying that Northwest Airlines are losing $1m annually because the British will not permit Northwest Airlines to serve Hong Kong (see *Flight*, July 12). He was putting forward arguments that PanAm should not be given permission to parallel Northwest's transpacific route. The senator said, "I am disturbed that, despite more than eight years' of negotiating, our government has been unable to secure agreement from the British on a relatively minor problem in international air transport. As a result . . . PanAm is now the only U.S. flag carrier serving Hong Kong. It seems incredible that the two governments are unable to reach an agreement which will maintain U.S. flag service between the two areas under their respective jurisdiction . . . I urge most strongly that the Administration spare no effort in attempting to persuade the United Kingdom government to honour its commitments to authorize direct service to Hong Kong by Northwest Airlines."

The American airlines are certainly being original in the design of terminals for construction at New York Idlewild's new "terminal city." Here, following PanAm's and United's plans, is T.W.A.'s $12m proposal, which vies even with PanAm's ("Flight," April 26) for unorthodoxy. Both have in common a vast sheltering canopy.





Here is a recent picture of Caravelle fuselage assembly at Toulouse Saint-Martin. Production is now spread over eight factories in France and one in Italy (Fiat). M. Georges Hereil, president of Sud Aviation, says that four Caravelles a month will be built as from May 1960; and that "if negotiations now on foot" materialize, existing facilities could attain a production rate of seven Caravelles a month. "Negotiations" now extend to South African Airways, who have included the Caravelle in their jet studies (see "Flight," November 15). A Caravelle is to visit South Africa early in the New Year for tropical tests.

C.A.B. DIGS IN ITS HEELS

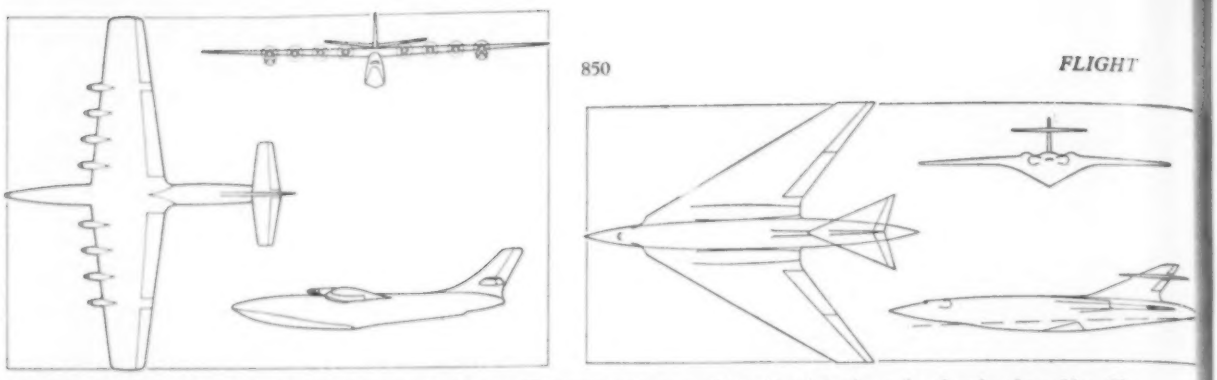
AGAINST mounting pressure on every hand, America's Civil Aeronautics Board remains steadfast in its stand against increases in airline fares. Dominating the thoughts of international operators at the resumed I.A.T.A. Traffic Conference in Paris, and in the face of increasingly shrill demands for higher fares from U.S. domestic operators at the opening of the General Passenger Fare Investigation, C.A.B. is sticking determinedly to its policy "that the general level of fares should be based upon the cost of the services provided, including a fair return on investment," and not on such airline-sponsored yardsticks as "profit margin" and "operating ratio."

The U.S. Air Transport Association says that the cost to the airlines of the 340 jets and turboprops now on order is over £714,000,000, or more than 25 times the combined earnings of all the domestic airlines. A clear indication of the trend of airline affairs may be inferred from a recent statement that the common stock of the 12 major trunk airlines has fallen to 64 per cent of its book value, whereas only a year ago the selling price was 122 per cent.

Hardest hit of all are Capital, who have asked the C.A.B. for Federal mail subsidies of £4,360,000 over the next two years. "We have repeatedly said that an emergency situation existed," the airline declared in their brief to C.A.B.; and they reminded the Board of the temporary six per cent increase it had already rejected. Capital conclude that they will require a subsidy of 30.73 cents per revenue aircraft-mile to balance losses of about £1,785,000 over the past three years, in spite of an increase in gross revenue from £17,850,000 to £33,930,000 during that time.

This appeal for mail subsidies by a U.S. domestic operator may be more likely to affect C.A.B.'s stand than the current demands for increases in fares, since the airlines and the Board are proud of the way that the major carriers have become independent of state aid. American Airlines, who are campaigning for a fare increase of 20 per cent, quickly announced that they would contest a subsidy to Capital on routes between the principal traffic centres of the Eastern U.S.A., where there was "neither need nor justification." Similarly, the Independent Airlines Association offered to take over Capital's routes without a subsidy.

The C.A.B. propose rates of return on investment of 8.9 per cent for the four major carriers and 9.5 per cent for the regional trunk lines—slender enough margins in view of the airlines' equipment commitments, but symptomatic of the C.A.B.'s declared policy of keeping the level of prices down not only for the ultimate benefit of the public but of the airlines as well.



Saben-Hart's flying-boat projects. The freighter, on the left, is a 476ft-span turboprop, with loading doors forward and under the rudder. The smaller—325ft-span—airliner (drawn to scale) is a much more tentative proposal with a skate-type hull and powered by very large turbojets.

CIVIL AVIATION . . .

THOSE MAMMOTH FLYING-BOATS

REACTION to the news that a London firm of consultant engineers is studying a project for a flying-boat with a gross weight of 3,000,000 lb has varied from the frankly sceptical to the cautiously non-committal. There has been scepticism because the proposal has come from outside the manufacturing industry, and because previous attempts to build very large aeroplanes have rarely been crowned with success. But there have been reservations of judgment because, in the light of recent events, no one is anxious to appear too dogmatic or too pessimistic about the trend of aircraft design over the next ten years.

The Saben-Hart flying-boat design was the outcome of a suggestion that it might be possible to ferry oil across the world's trouble-spots. Investigations were made, but the idea was rejected on economic grounds; the airborne tanker would be more expensive—although not prohibitively more expensive—to operate than a sea-going super tanker. Further studies were then made into the transport by air of other bulk commodities, such as frozen meat or grain, and results seemed sufficiently encouraging for this consultant firm to devote a part of its energies to completing a project study. But that is as far as these projects can be taken by the company, who have neither the staff to complete the detail design nor the manufacturing capacity to tackle such a major undertaking.

It needs to be appreciated immediately that a flying-boat of this size is not simply a monster new aeroplane, but the mobile unit of a rational—if futuristic—transportation system involving complex ground (and water) installations; and in any serious assessment of this project the likelihood of large flying-boats upon the air-freighting scene of the 1970s must first be accepted.

The passenger version, it seems, is a less serious alternative which has not received such close consideration as the freighter. But no doubt the news impact of a 1,800-seat flying-boat with no windows served to focus attention on the other design.

The basis of the project is a detailed study by Mr. R. B. Cullum, project engineer at the aircraft division of Saben-Hart and Partners, Ltd., at Bournemouth, into the trends of freighter progress and of structural design. Upon these admittedly extrapolated long-range forecasts, the firm concludes that there will be a place for a freighter of this size in about ten to fifteen years' time and they are sufficiently optimistic about the veracity of their prediction to consider it worthwhile devoting perhaps 18 months' work of a six-man project group to the preparation of a design brochure. Many of the problems associated with carrying the project further, such as finding at least £20m (and probably considerably more) to build a prototype, a manufacturer willing to construct and develop an aircraft of this size, and operators to pioneer 1,000,000-lb-payload services, remain unanswered, but Saben-Hart report interest from a shipping company and say that K.L.M. have expressed their willingness to discuss the specification when it is prepared.

For power units Saben-Hart are looking to Pratt and Whitney, from whom, they say, they have obtained preliminary dimensional information about a 20,000 s.h.p. turboprop that might be developed to meet their 25,000-27,000 s.h.p. requirement. Pratt and Whitney have a turboprop of almost this size (15,000 to 20,000 s.h.p.) on the shelf—the T57, which in 1956 was tested in the nose of a Douglas C-124. But since the cancellation of the C-132 transport, for which the engine was intended, Pratt and Whitney have apparently shown little further interest in the design.

It is possibly unfair to quote too many details of any project at such an early stage; particularly, as in this case, when tunnel and tank tests have not been carried out. That this project is a paper one and, at the moment, has pretensions to being nothing more, means that outline, constructional technique and engineering features are of a necessarily tentative nature.

One of the more surprising aspects of these flying-boats is the prominence that has been given to the intended use of Callotan dimpled sheet, which has a constant moment of inertia regardless of the direction of cut. Extrapolation of structure-weight reduction over the past few years, combined with the use of this technique, has led Saben-Hart to talk in terms of structure-weights approaching 15 to 18 per cent of the all-up weight. This seems to be the weakest part of the company's reasoning, since, striving to extend one technique (and a very new one, for aircraft purposes, at that) might well prejudice the structure as a whole, and the problems of manufacture on this scale are not—as others have found before—easy to resolve. Certainly, simplification rather than sophistication is the aim, for, by its very nature, an aircraft nearly equal in displacement and capital cost with a fair-sized ship must be designed for a life in excess of the ten-odd years accorded to current civil aircraft.

There is still a good case to be made for the flying-boat and we have good reason to suggest that there are signs of reawakened interest in other quarters. The very large freighter flying-boat is aimed at the markets of ten to 15 years hence, and fantastic as this project may seem now, time may prove the basic wisdom of the concept. Long and deliberate though discussions would have to be before any transport project of this nature was undertaken, it is encouraging that consideration is being given to new air transport systems for a decade-and-a-half hence. A. T. P.

UNITED DECIDE AT LAST

THE last of America's "big four" domestic airlines, United, have now finally decided on their choice of aircraft for medium-range operations in the sixties. On November 22 the president of the airline, Mr. W. A. Patterson, announced that he had ordered 11 Boeing 720s. In addition, Mr. Patterson announced a repeat-order for ten J57 DC-8s, to bring his total long-range jet fleet to 40 (25 of them with J57s).

The Boeing 720 is a redesignation of the Boeing 717, which—to add to the confusion—was previously known as the 707-020. The 720 will be powered with "a new and lighter-weight version of the Pratt and Whitney J57." Dimensions are the same as for the Boeing 717; fuel tankage is about 9,600 Imp. gal compared with the 8,400 Imp. gal previously quoted for the 717; payload (undefined) is given as 31,000 lb; seating capacity is quoted by United as 100 to 125.

From all this it appears that the 720 is not much different from the 717 (presumably now extinct)—in other words, it is a 707-120 with reduced fuel tankage, de-rated J57s, a refined structure, and components made on the same jigs as the 707-120. It is, in effect, Boeing's answer to the medium-range Convair 880, which was at one time very close to being ordered by United.

Mr. Patterson quotes a price of $100 million for ten DC-8s and 11 Boeing 720s. Since his 30 DC-8s already on order represent an investment of $175 million, it can be deduced that the price of the 720 is about $3.8m (£1.35m)—not bad value (it includes spares) for a jet of the 720's apparent earning capacity. It is a price which seems to justify the soubriquet "bargain-basement special" which Boeing gave to the 717.

United have already arranged the financing for the 30 DC-8s; and arrangements "are being completed" for an additional $100 million credit from a group of banks headed by the First National City Bank of New York. The 720s will be delivered between April and September 1960.

According to the American *Aviation Daily*, United plan to order a total of 92 jet transports by 1965. This source reports Mr. Patterson as saying that 30 per cent of his jet fleet will be DC-8s, 40 per cent medium-range (now confirmed as 720s), and 30 per cent short-range. All that he would say about the short-range

Mr. Kruschev and Mr. Tupolev relax in the Tu-114 at Moscow Airport recently. Some notes on this new Soviet transport—which has apparently not yet flown—appear on page 828.

requirement when he announced the 720 order was: "We expect our third jet-age stage will be the acquisition of turbine-powered aircraft for our short-range segments which we are postponing until we have our long and medium range equipment programme well advanced."

BY VISCOUNT TO GHANA

AS from January 6 next, the British independent airlines Airwork and Hunting-Clan will introduce Viscounts on to I.A.T.A.-rate tourist services to Ghana *via* Las Palmas, Gambia and Sierra Leone.

It will be recalled that, last June, the Minister of Transport and Civil Aviation agreed that the two companies—in view of Ghana's independence—should be allowed to operate a new service at I.A.T.A. tourist rates to Accra *via* Bathurst and Freetown. The Minister, who was accepting the Air Transport Advisory Council's recommendations on the whole future of Colonial-coach services, further agreed that there should be no restriction on the type of aircraft used. The new service just announced by Airwork and Hunting-Clan is the operational fulfilment of these recommendations, which further provided for the independents to have a 30 per cent share of T.34 services when these are introduced on to African routes.

Because of the greater speed of the Viscount (Vikings are at present used on the independents' West African Colonial-coach route) there will be only one night stop. This is attractively scheduled for Las Palmas—where the companies concerned, incidentally, are hoping to secure traffic rights.

"WITHOUT FOUNDATION"

FOLLOWING a statement made in a British daily newspaper last Monday to the effect that the accident to the Britannia 300 prototype at Filton on November 6 was caused by the propeller on the outer starboard engine suddenly going into reverse pitch, de Havilland Propellers, Ltd., made the following announcement:—

"We have already carried out, on behalf of the Chief Inspector of Accidents of the Ministry of Transport and Civil Aviation, a careful investigation of the propellers fitted to the Britannia aircraft which was involved in the accident near Filton on November 6. This investigation has shown that these propellers were functioning correctly at the time of the accident. There was no foundation for the article which was published."

THE PILOTS AND THE PROTEUS

THAT valuable sounding-board of pilot opinion, B.A.L.P.A.'s *The Log*, this month contains the comments of a B.O.A.C. pilot, Capt. A. Spooner, on the performance of the Proteus 705 in the Corporation's Britannia 102s. The article is aimed particularly at those pilots who are with the Corporation but not in the Britannia fleet—men who laymen might assume have inside information. "They can, of course," says Capt. Spooner, "quote the official B.O.A.C. statements, but those in uninformed hands can be grossly misinterpreted. To John Bull or John Doe an unscheduled engine change is but another name for an engine failure.

"Bumps, auto-relights and flame-outs are three separate issues of a common problem. Between February 13 and August 23 there were 2,646 officially recorded bumps, none of which damaged the engine; they might be compared with a backfire on a piston engine. There were 272 relights between February 1 and September 8; they are an operational anxiety rather than a hazard. And there were 44 flame-outs in the same period, i.e., one in every 1,660 engine hours. They are serious, but 38 out of 44 have occurred along the equatorial belt and by no means all have meant an unscheduled engine change was necessary." There have been 20 unscheduled engine changes due to ice in 56,850 engine hours, but only four were cases for feathering. The Britannia has proved to be slightly more favourable in hours flown between featherings than the DC-7C; although 75 per cent of all featherings on the latter aircraft were precautionary or due to false alarm.

Ice has not been the only problem encountered with the Proteus, Capt. Spooner goes on to say, and engines now fitted with Nimonic 100 first-stage turbine blades and "moved back entry guide vanes" have been greatly improved: modified engines have run 21,795 hours with only two unscheduled changes. The Britannia 300 has suffered no icing problems in transatlantic crossings, "but the 755, like the 705, will have to suck it and see."

* * *

Last week, we quoted a figure given by Rear Admiral Sir Matthew Slattery for the Britannia's daily utilization after eight months in service. For comparison, here are figures for other aircraft eight months after they went into service with the Corporation:—

Aircraft type	Date of entry into service	Number in fleet after eight months	Utilization after eight months hr/aircraft/day
DC-7C	8.1.57	10	8
Britannia ...	1.2.57	15	7¼
Comet 1	2.5.52	9	4+
Argonaut ...	23.8.49	22	4
Hermes	19.3.50	14	4+
Stratocruiser ...	13.12.49	10	5
Constellation 749	29.7.48	3	5+

TRANSATLANTIC BRITANNIA PLANS

ALTHOUGH B.O.A.C., whose two Britannia 312s so far delivered have completed three transatlantic proving flights, have made no precise statement about the date they hope to start services, it is understood that the present target-date for the inaugural service is December 19. Achievement of this target, which compares with the "within-the-first-three-months-of-1958" quoted previously, depends on the outcome of further proving flights, and no doubt upon the outcome of current Bristol tests with Britannia 312 G-AOVA, which left Bristol on November 25 for Singapore where, "during the next few weeks, it will make an intensive series of weather-exploration flights."

This aircraft, commanded by Bristol's chief test pilot Walter Gibb, and with a team of 40 engineers on board, is fitted with Proteus 755s incorporating two forms of modification designed to eliminate the engine icing problem. The two outboard engines are equipped with Bristol's "boundary layer" modification (*Flight*, October 25), whereby air tapped from the compressor is re-introduced through 25 small nozzles, spaced about six inches apart, in the intake duct. These direct jets of air to accelerate the boundary layer in the critical area of the intakes where ice has been accumulating. When in use, this system will cause a small increase in specific consumption, which in practice will mean a 1,500ft reduction in cruising altitude, and a two per cent loss of range if the system were in operation all the time (which, of course, it would not be). The other modification—to the inboard engines of G-AOVA—increases the heat applied to the walls of the intake; these will now be heated (from behind) up to 300 deg C instead of the standard 180 deg C.

Because B.O.A.C. will have only three or four Britannia 312s delivered by December 19, the service will begin initially on a once-weekly basis, the westbound crossing being made in daylight. Accommodation will be *de luxe* to begin with.

Meanwhile, El Al Israel Airlines are aiming to inaugurate their transatlantic Britannia 313 services between Tel Aviv and New York, Paris and London *via* Rome "before the end of December."

Now flying is this extremely efficient-looking little six-seat general-purpose Soviet transport. It is the work of Antonov, and it is called the Bee. Designated An-14, it is in the Miles H.D.M. 106 class.

CIVIL AVIATION . . .

BREVITIES

THE International Federation of Independent Air Transport (F.I.T.A.P.) has elected Mr. G. H. Freeman, chairman of Transair, Ltd., as its president for the year beginning December 10, 1957. He succeeds A. Cdre. G. J. Powell, who was forced to resign through ill-health. Mr. Freeman will, incidentally, become president of F.I.T.A.P. at the end of his term of office as chairman of the British Independent Air Transport Association.

* * *

Seaboard and Western have applied to the C.A.B. for an extension of their transatlantic freight service to Moscow, via Berlin and Warsaw.

* * *

The four engines of the B.E.A. Viscount which made a forced landing north of Copenhagen on November 17 are to be returned to England for examination.

* * *

The Swedish airline A.B. Linjeflyg, operated jointly by the Swedish section of S.A.S. and two publishing companies, may buy Friendships to replace its DC-3s on domestic services.

* * *

There is a possibility that Aer Lingus may dispose of their Viscount 700-series and replace them with more V.800-series aircraft. This would give the airline a fleet of seven Viscount 808s.

* * *

Following criticisms in *The Daily Telegraph* of passenger handling facilities at London Airport Central, the M.T.C.A. say that the Air Transport Advisory Council (whom they asked in 1956 to inquire into passenger movements through the building) are expected to report to the Minister next spring.

* * *

The missing PanAm Stratocruiser *Romance of the Skies* was found in the Pacific 1,000 miles north-east of Hawaii on November 14. The wreckage was severely charred and there were no survivors from the 44 people on board. From 15 bodies recovered, some of them wearing lifejackets, it was apparent that passengers had been given warning of an impending ditching, but no distress message had been received.

* * *

A Bristol 170 Freighter of Strait's Air Freight Express, New Zealand, crashed near Christchurch on November 21. Three members of the crew and one passenger were killed. According to a news-agency report, eyewitnesses stated that the starboard wing broke away from the fuselage when the aircraft was about 1,500ft up. The airline's activities are said to have been suspended pending an investigation.

It was on December 14, 1955, that Mr. Robert F. Six, president of Continental Air Lines of Denver, Colorado, U.S.A., put his autograph on a contract with Vickers for 15 Viscount 810/840s. Here he is, a few days ago, autographing his first aeroplane, on the Weybridge assembly line.

A new American helicopter operator, Indair Inc. of 2 Park Avenue, New York, has ordered three Vertol 44s. The manager is Mr. William H. Gunther.

* * *

United Air Lines announce plans for a $4m jet-airliner maintenance base at San Francisco international airport. This is in preparation for the inauguration of DC-8 jet schedules in 1959, and for "other turbine-powered aircraft to be ordered in the future" (see previous page).

* * *

A novel and entertaining way of selling air travel was introduced by S.A.S. at the Royal Festival Hall, London, on Tuesday, November 19, with a musical sales show introduced by Mr. Wagn Christensen, S.A.S. general manager, before an audience of nearly 3,000 travel agents.

* * *

The Ghana Minister of Communications has received proposals from a number of operating companies for the establishment of a Ghana airline. K.L.M., in particular, is shortly to submit its final proposals. A B.O.A.C. team is expected soon in Ghana for discussions.

* * *

Disagreeing with Lord Weeks' comment that an operator should not enter into public controversy with his suppliers, Mr. Eric Rylands, managing director of the British private airline Skyways, comments in a letter to *The Times* that this statement pre-supposes that all operators enjoy freedom from public criticism: "Our two great air corporations do not enjoy such immunity. Surely, then, they should be free to comment on matters that might give rise to criticism of them? The corporations are operated with efficiency and dignity, and may be relied upon to exercise judgment."

BRITISH AIR SAFETY STANDARDS (continued from page 831)

Hermes to a lesser extent—probably resulting in the re-routing of some long-haul (e.g., trooping) services. The half-dozen or so DC-4s in British service are not likely to be affected much, as these aircraft are pretty well up to standard. The same applies to the Argonauts—although the main operators of this type, B.O.A.C., have already been voluntarily observing limitations stricter than those required by law. Tudors are fairly sensitive to high temperatures and high aerodromes, and some weight restrictions in such conditions—and to meet the two-engine-out case—may be required. Doves are not likely to be much affected, but Dragon Rapides will be quite seriously restricted by their single-engine performance, particularly in light of the new visibility requirements. The effect of the changes on the Solent flying-boats is, in view of an impending public inquiry, *sub judice*.

There are, of course, ways in which the independents will modify certain of their aircraft to assuage the effects of the new requirements. It is understood that the Bristol Aero-Engines, Ltd., have a scheme for the modification of the Hercules 600 series engines of the Viking and the Freighter 21; strengthening of the power section of these 1,690 h.p. engines permits a substantial increase in power. There is also a possibility that the Hercules 700-series engines, as fitted to the Hermes for example, can have their blower ratios reduced to produce greater power at normal operating altitudes. And the independent company, Transair, are likely to do big business in the supply of kits for their undercarriage modification to the DC-3. This modification, and its beneficial effects on performance, were discussed in *Flight* of June 29, 1956.

The overall commercial effect cannot be gauged, but it is likely to be serious in an industry which is already apparently operating a bit near the knuckle in trying to make money out of low-revenue-rate traffic. Certainly one can appreciate the grounds for independent grumbles about a Government policy which—they aver—on the one hand restricts their operations to short-term low-revenue business (making it difficult for them to re-equip) and on the other hand intends to make it harder to operate their existing equipment economically.

But, on balance, it seems fair to comment that higher safety-standards are overdue; that even when they come into force they will still not be as high as the standards applied to the design of modern aircraft; and that all this may hasten the day—perhaps brought nearer already by enlargements of the independents' opportunities—when all sections of British air transports operate more modern equipment.

The independent market for Viscounts, as discussed in *Flight* of November 15, may be enlarged sooner than it otherwise might have been; and though there will be no sudden overnight demand for aircraft like the AW.650 and Dart Herald, the home-market for these aircraft—which with Viscounts should cater for most kinds of independent activity—may be potentially larger. The splendid vision of British independents flying fleets of these three aircraft (with their common Dart powerplants) may be idealized; we shall first see a period in which the airlines will be learning to live with the new restrictions, and there will be a programme of modifications.

But there may be sizeable orders for newer aircraft in a year or two's time, particularly from those independents who see that the future to which they aspire will not be brought nearer by clinging on to the older types—faithful servants of the air transport community though they have been.

J. M. R.

SERVICE AVIATION

Royal Air Forces and Naval Aviation News

N.Z. Air Board Appointment

PREVIOUSLY Director of Technical Services in the R.N.Z.A.F., G/C. G. C. Hunter has been appointed to the New Zealand Air Board as Member for Supply. He succeeds A. Cdre. I. G. Morrison, who was due to leave for the U.K. this month to join a course at the Imperial Defence College.

AAFCE Appointment

NEXT month G/C. Leslie Fox, Deputy A.O.A. at H.Q. Fighter Command, takes over the appointment of Assistant Chief of Staff for Operations and Training at H.Q. AAFCE with the acting rank of air commodore. He succeeds A. Cdre. A. Foord-Kelcey, who has been selected to attend the Imperial Defence College.

Since the war, during which he was awarded the D.S.O. and D.F.C., G/C. Fox has served at Air Ministry, commanded R.A.F. Horsham St. Faith, been S.A.S.O. of No. 2 Group in Germany and commanded R.A.F. Colerne. In 1941 he was chosen to captain one of the two aircraft used to take the British Mission to Russia and bring the Soviet Mission to this country, and the following year he took part in the original survey of the direct air route between Ceylon and Australia.

Air Physiology in 2nd T.A.F.

INCREASED facilities for training aircrew in the use of their survival equipment, and for studying human factors in high-speed and high-altitude flying, are being made available in the 2nd T.A.F. Aviation Medical Centre at R.A.F. Wildenrath. A night vision room is under construction (as an addition to the existing premises); equipment has been installed for aircrew to test ventilated flying suits; and two more research projects—following the one recently completed on the toxic effects of certain fuels—have been put forward for approval by Air Ministry.

The chief purposes of A.M.C. work (which was fully described in a *Flight* article for August 9) are to educate aircrew in the use of their survival equipment and to train them to recognize symptoms which may occur at high altitudes. (As the C.O., S/L. P. Norris, who himself trained as a Hunter pilot after gaining his medical qualifications, puts it: "Aircrew used to flying in pressurized cabins have no idea how unfriendly the atmosphere is at 50,000ft.") Thus the use of oxygen equipment and the effects of anoxya are demonstrated in a decompression chamber; in a specially equipped test-room, where the temperature can be raised to 150 deg F with 100 per cent humidity, the efficiency of a ventilated flying-suit is shown; and the night-vision room, when completed, will enable tests to be carried out in the sighting of moving objects without the usual daylight points of reference.

This room has been planned to a design by F/L. E. R. J. Emery, one of the A.M.C. staff, who based it on his study of similar equipment used by the Royal Netherlands Air Force at Soesterberg. It is about 8ft wide at the entrance, which is raised some 3ft above ground level, and somewhat narrower at the opposite wall—20ft away—where a white screen is to be painted. In front of the screen is a railed-off "pit" about 4ft wide where a panorama can be placed. Night-vision tests, and instruction in the protection of the eyes, will be included in aircrew courses at the Centre when the room has been completed—which will probably be in two months' time.

At present, owing to the defence cuts and consequent disbandment of several 2nd T.A.F. squadrons, fewer aircrew are attending courses. With the establishment of the West German Air Force, its members also may in future receive instruction at the A.M.C.

No. 11 Sqn. Disbands

TOMORROW No. 11 Squadron, which was formed at Netheravon in November 1914, is to be disbanded at R.A.F. Wunstorf in West Germany. At its final parade there last Friday the C-in-C. 2nd T.A.F., Air Marshal Sir Humphrey Edwardes Jones, and the A.O.C. No. 2 Group, A-V.M. S. R. Ubee, bid the squadron farewell as a unit of 2nd T.A.F.

During its long history No. 11 Sqn. has achieved several distinctions. In 1915, after being inspected by King George V at Upavon, it provided what is believed to have been the first air escort ever given to royalty when six of the squadron flew above the king's car as he drove to Bulford. Then in November that year G/C. G. S. M. Insall won the V.C. while serving with No. 11 as a 2nd Lt.; and in 1916 2nd Lt. Albert Ball—later also to be awarded the V.C.—gained his first decoration, the M.C., whilst a member of the squadron. (Three of his combat reports are now among its proud possessions.) One of No. 11's more dubious distinctions is that of having provided von Richthofen with his first victim.

In the First World War period of its existence, No. 11 Sqn. flew the Vickers Fighter (the Gun Bus), Nieuport Scouts, F.E. 2bs and Bristol Fighters. It was disbanded in 1919 then re-formed in 1923 at Andover and after five years' home service posted to India, where it remained—operating with Westland Wapitis and Hawker Harts—until moving to Burma and thence to Aden shortly before the

Proud of their claim to be the only aerobatic team from an R.A.F. night fighter squadron, and the Service's sole eight-man four-aircraft aerobatic formation, "The Moonrakers" of No. 68 Sqn.—mounted on Meteor N.F.11s—here show off their combined prowess. A 2nd T.A.F. unit, the squadron is based at R.A.F. Laarbruch.

SERVICE AVIATION . . .

Second World War. In the inter-war period it also flew D.H.9as, Fairey Fawns and Hawker Horsleys.

No. 11 operated in the Middle East, Greece, India, Burma and Malaya during the last war, being armed with Blenheims and later with Hurricanes and Spitfires (reverting on the latter aircraft from a light bomber to a fighter rôle). It finally went to Japan and was disbanded there in 1948.

The third and—up to now—final period of the squadron's history began in Germany nine years ago when No. 107 Sqn. was disbanded and re-numbered 11, which was then equipped with Mosquitoes. In 1950 it was re-armed with Vampires and two years later became the first R.A.F. squadron to be equipped with Venoms, its F.B.1s being the mounts for a very successful formation aerobatic team.

No. 11 Sqn's C.O. at the time of disbandment was S/L. D. G. Evans, a Canadian, who captained the R.A.F. ice hockey team during the seasons 1948-49 and 1949-50. The squadron was presented with its standard at Wunstorf—its base since 1950—in August 1954.

Shephard Essay Prize

OFFICER Commanding R.A.F. Station Tern Hill, G/C. W. Carter, D.F.C., has won the Gordon Shephard Memorial Prize Essay Competition for the third successive year—an accomplishment never before achieved in the 39-year history of the contest. W/C. F. G. C. Gilbert, of the Equipment Branch, Air Ministry, was second, W/C. J. F. Powell, O.B.E., M.A., Senior Tutor at the R.A.F. College, Cranwell, Lincs, third, and A. Cdre. M. W. Palmer, LL.B., Director of Legal Services, Air Ministry, fourth.

Recent Appointments

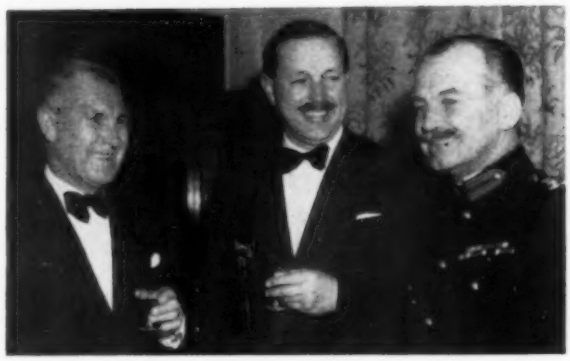
AMONG appointments which have recently been announced by Air Ministry are the following:—

G/C. D. S. Kite to the Ministry of Supply; G/C. J. B. Ross to be Senior Medical Officer, H.Q., No. 1 Group.

W/C. J. H. Hunter-Tod to the British Joint Services Mission (U.S.A.) (with the acting rank of group captain); W/C. W. J. Maggs to the Air Ministry, for duty in the Department of the Air Member for Supply and Organization (with the acting rank of group captain); W/C. W. G. Morgan to the R.A.F. Record Office, Gloucester, for administrative staff duties (with the acting rank of group captain); W/C. C. E. Castle to R.A.F. Colerne, Wiltshire, for technical duties; W/C. T. L. Davies to H.Q., F.E.A.F., for technical staff duties; W/C. L. C. Inglefield to H.Q., Home Command, for air staff duties; W/C. J. D. de S. McElwain to R.A.F. West Raynham, Norfolk, for technical duties; W/C. H. T. Sutton to H.Q., Home Command, for recruiting staff duties; W/C. E. J. Watts to R.A.F. Acklington, Northumberland, for technical duties; W/C. E. M. Webb to H.Q., Technical Training Command, for air staff duties.

S/L. A. L. Baker to H.Q., F.E.A.F., for technical staff duties (with the acting rank of wing commander).

This Beaver, to go to the R.A.A.F. Antarctic Flight, is seen at Rathmines, N.S.W.



A. Cdre. G. Carter (left), managing director, Bristol Aeroplane Co. (New Zealand), Ltd.; A. Cdre. I. G. Morrison, formerly (as recorded on page 853) Air Member for Supply; and Brig. J. R. Page, Quartermaster-General, N.Z. Army, at a recent dinner.

IN BRIEF

The R.N.Z.A.F., which was constituted as a separate armed service under the Air Force Act of 1937, reaches its 21st anniversary next April. The main celebrations will be at Ohakea R.N.Z.A.F. station on Air Force Day, March 29, and there are to be station parades and social functions during March and April.

* * * * * *

G/C. A. V. R. Johnstone has been appointed air adviser to the Malayan Government, with the rank of air commodore.

* * * * * * *

Aircrews and ground crews for the first R.N.Z.A.F. Canberra squadron to be stationed in Malaya—due to start duties there on July 1 next year—are to receive training in this country.

* * * * * *

A Valiant piloted by W/C. F. C. D. Wright, C.O. of No. 148 Sqn., crossed Aldergrove in Northern Ireland four hours and ten minutes after leaving Goose Bay, Labrador, when it returned to the U.K. recently after a goodwill visit to the R.C.A.F. It had previously flown the 1,100 miles from Ottawa to Winnipeg in 1 hr 51 min—seven minutes faster than the record time set up in 1953 by a CF-100.

* * * * *

A Beverley of R.A.F. Transport Command left Abingdon on November 18 for a tour of Africa to gain experience of operating on a self-supporting basis away from scheduled routes.

* * * * * *

For the second time since the competition started in 1953, the Marine Craft Section at R.A.F. North Front, Gibraltar, has won the Marine Craft Unit Efficiency Cup. No. 1113 M.C.U., Holyhead, was second and No. 1107 M.C.U., Newhaven, third.

* * * * *

The next competition for the award of R.A.F. scholarships, under the scheme designed to help boys to remain at school until they are old enough and educationally qualified for entry to Cranwell or Henlow, will be held next February and applications must reach Air Ministry (A.R.Is) not later than December 31.

* * * * * *

A party of R.A.A.F. technicians is to leave Sydney for the United States by air on December 6 to make preparations for delivery of the 12 recently purchased Lockheed C-130s. Led by G/C. W. D. Mason, Director of Equipment Policy and Administration for the Department of Air, members of the party will discuss technical and equipment details with the U.S.A.F. and the manufacturers.

Temporarily earthbound, "The Moonrakers" (seen in action on the previous page) are, left to right: F/L. J. M. A. Parker and F/O. J. B. Blakeley (No. 1); F/O.s G. W. Jones and M. Boggis (No. 2); P/O. J. Davoine and F/Sgt. E. McMillan (No. 3); and F/L. R. L. Holmes and F/O. D. Blundell (in the box position).

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns; the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

The Tu-114

I WONDER if the significance of the Soviet Tu-114 turboprop airliner is generally recognized either here or in the U.S.A.? It appears to be an aeroplane of more advanced concept than the Bristol 187, which is still in the design-study stage; and it is likely to provide Comet speed, or higher, with something like Britannia economics. It would be particularly interesting to know what efficiency the Russians are obtaining from the contraprops.

London, W.1. R. E. SMITH.

[Some observations on the Tu-114 by Mr. F. H. Robertson, chief project engineer of Short Bros. and Harland, Ltd., appear on pages 828-829 of this issue—Ed.]

Restrictions on the Private Pilot

ONLY *Flight* would be good enough to let me use its Correspondence page to say something bordering on the unmentionable—a good word for the M.T.C.A. staff, in this case at Eastleigh. I have always found them to be most helpful to professional and private pilots alike and, if anything, over-tolerant of the irresponsibility of some of the latter. Mr. Jones [Correspondence, November 15] should realize that his quotation from the Air Navigation Order cannot be stretched to cover every irregularity.

Some private pilots (and, regrettably, some of their instructors as well) regard all regulations as restrictions and are frankly ignorant of the reasons for them. These people are dangerous both to themselves and to others. Nobody, they say, is going to tell them when and where they can fly.

Part of the trouble is that so many instructors (and, indeed, so many C.F.I.s) have never obtained a Commercial Licence—"on principle," as one told me. He regarded airline pilots as "ruddy bus drivers," and the M.T.C.A. as a sort of M.V.D. It need hardly be said that he had no glimmering of what Airways and Control Zones are for; he seemed to think that they were there to annoy him personally.

Private aircraft have as much right to be in the air as any others provided that their pilots take the regulations seriously, and have the equipment on board to comply with them, as have many of the American private aircraft referred to.

Finally, a word for that "one-eyed pilot." While I, too, think I could run the Ministry better than the Minister, I would tell the "one-eyed pilot" about a friend of mine who got a fly in one eye on finals. He landed with the other one.

Jersey, C.I. AIRLINE PILOT.

Tabloid or Tweenie ?

THE latest article in your series "Historic Military Aircraft" by J. M. Bruce is as interesting and scholarly as its predecessors. I am particularly glad that Mr. Bruce is now devoting one of his articles to that famous aeroplane, the Sopwith Tabloid, whose design had such a lasting effect on aircraft development.

One part of the Tabloid story is perhaps worth considering in more detail. Mr. Bruce accepts without question the official account (given in A.P.125, *A Short History of the Royal Air Force*) of the historic R.N.A.S. raid on Cologne and Dusseldorf on October 8, 1914, which was perhaps the first really successful air attack on a ground target of all time. As stated by Mr. Bruce, the official story of this action is that the attack was made by two Sopwith Tabloids from Antwerp—No. 167 flown by Sqn. Cdr. Spenser Grey and No. 168, flown by F/L. R. L. G. Marix.

I have for some time had a theory that Spenser Grey did not, in fact, use a Tabloid on this operation but that he flew a quite different and little-known Sopwith aeroplane called the Tweenie. My reason for thinking this is that on page 334 of Vol. I of *The Great War—the Standard History of the All-Europe Conflict*, which was a contemporary serial history edited by H. W. Wilson, there is an illustration claimed to be of "Squadron Commander Spenser Grey after the second attack on the Dusseldorf airship shed." It shows an aeroplane on the ground and, if this obviously partly inaccurate caption contains some truth, it depicts Spenser Grey's machine after its return from Cologne, and shortly before its destruction on the ground by enemy shellfire during the fall of Antwerp.

The photograph is quite certainly not of a Tabloid nor of an aeroplane bearing the serial number 167. The aircraft appears, in fact, to be closely similar to the instructional machine for Sir Winston (then Mr.) Churchill which the Sopwith company built for the Admiralty a few months before the outbreak of the Great War. The only apparent difference is that Spenser Grey's machine seems to have a fixed vertical fin forward of the rudder. I believe the serial number of the aircraft built for Mr. Churchill was 149 and, although the tail of the machine at Antwerp is partly obscured by somebody standing in front of the aircraft, it looks as if it bears this, or a very similar, number. It should be possible to check the serial from the original of the illustration of the "Churchill" on page 679 of *Flight* for November 30, 1951. [Yes, examination of the photograph clearly reveals "149"—Ed.]

I believe several Sopwith dual-control trainers with side-by-side seating, similar in design to the original machine built for the First Lord, were supplied to the R.N.A.S. They bore a family resemblance to the earlier Tabloid but were much larger and heavier. They had two-bay wings of 36ft span (the Tabloid was single-bay of 25ft 6in span), a fuselage 24ft 6in long (Tabloid, 20ft 4in) and a loaded weight of 1,640 lb compared with the 1,060 lb of the Tabloid. The engine was a 100 h.p. Gnôme Monosoupape rotary.

Although sometimes referred to as the "Churchill" in more recent accounts, this type was, I believe, known at the time as the "Tweenie." I had it on the authority of the late Mr. Fred Sigrist that the name derived from a well-known music hall artist.

It would be most interesting to know whether the aircraft which attacked Cologne was the same as that built for Mr. Churchill or whether it was one of the subsequent "production" batch. Spenser Grey, with Lt. Gerald Aldwell as passenger, is said to have spun the original machine into the ground at Eastchurch. However, it is just possible that this aircraft was rebuilt—perhaps with the addition of a fin?—before it was used by Spenser Grey for his historic attack.

Ruislip, Middx. PETER W. BROOKS.

The First Cabin

YOUR correspondent Mr. Maurice Austin has raised the question of the first cabin aeroplanes. Those of us who try and sort out such things have long ago come to the conclusion that "the firsts" in aeronautics must generally be confined to those devices, inventions, etc., which *worked*, at least tentatively: otherwise we should all be flooded with wonderful ideas and constructions—and some of them were indeed wonderful—which never came off, or in the case of whole aircraft, never took off and flew. So the 1912 Avro is still the first cabin machine, because it flew. The Piggott monoplane shown at Olympia in 1911 did not fly. To be pedantic, the first cabin aircraft ever built and tested—but it did not fly, despite its supporters—was Ader's first *Eole* of 1890, with its totally enclosed cabin and windows.

As for the 1911 Cessna, we can find nothing. David Sawers and I, after our search, have come to the conclusion that it is spoof. No authoritative source makes any mention of such an aircraft or such a name at that time: Cessna seems first to appear in 1927.

London, W.1. C. H. GIBBS-SMITH.

FORTHCOMING EVENTS

Nov. 29. R.Ae.S.: Graduates and Students Section: Annual Dance.
Dec. 3. R.Ae.S.: Section Lecture: "Some Techniques of Engine Testing under Simulated Icing Conditions," by O. R. Ballard, A.F.R.Ae.S., and P. J. Sharp.
Dec. 4. Kronfeld Club: Film Show.
Dec. 6. Helicopter Association: "The Digital Computer as a Helicopter Flight Simulator," by J. M. Harrison, A.F.R.Ae.S.
Dec. 10. R.Ae.S.: Graduates and Students Section: Film Show.
Dec. 11. Aircraft Recognition Society: December Forum.
Dec. 11. Kronfeld Club: "Life on the Planets," by Dr. A. E. Slater.
Dec. 12. R.Ae.S.: Main Lecture: "Ramjets," by R. P. Probert.
Dec. 14. Plymouth Aero Club: Christmas Party.
Dec. 17. R.Ae.S.: Section Lecture: "Comparison of Ducted Fan, By-pass and Straight Jet Engines," by Dr. S. G. Hooker, F.R.Ae.S.
Dec. 18. Kronfeld Club: Christmas Party.
Dec. 21. Lasham Gliding Centre: Christmas Party.

R.Ae.S. Branch Lectures (to Dec. 20):—

Dec. 2, *Halton*, Film Show. Dec. 3, *Boscombe Down*, "The Weapon System Concept," by H. Davies; *Luton*, "Fuels, Past, Present and Future," by Dr. R. A. Roper. Dec. 4, *Bristol*, "Automation," by J. Sargrove; *Leicester*, "The Economic Basis for the Design of a Freight Aircraft," by A. H. Stratford. Dec. 5, *Cambridge*, "The Development of the P.1," by F. W. Page. Dec. 9, *Halton*, Lecture by E. A. Tennant. Dec. 10, *Bristol*, "Aviation Finance," by G. E. Knight; *London Airport*, "Airline Economics," by S. Wheatcroft. Dec. 11, *Brough*, "Future Trends of Aircraft Propulsion Units," by A. Cdre. F. R. Banks; *Chester*, Lecturettes; *Christchurch*, "Fatigue Tests on the Bristol Britannia," by Dr. W. J. Strang; *Hatfield*, "The Domain of the Helicopter," by R. Hafner; *Reading*, "Investigation of Aircraft Accidents," by E. L. Ripley; *Southampton*, "The Weapon System Concept," by H. Davies; *Weybridge*, "The International Geophysical Year," by Prof. H. S. W. Massey. Dec. 12, *Cheltenham*, "Problems of Progressive Failure," by Sir Alfred Pugsley; *Glasgow*, "Fatigue and Fail-Safe in Aircraft Structures," by N. F. Harpur. Dec. 16, *Henlow*, "Artificial Satellites," by Dr. M. W. Ovenden. Dec. 20, *Weybridge*, Annual Dance.

PASSIVE REFRIGERATION

A New Heat-Insulating Technique

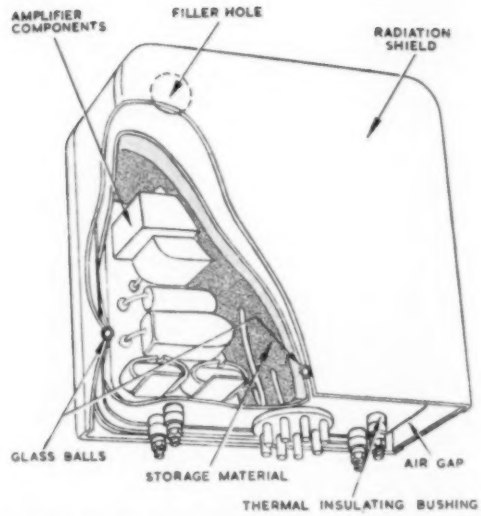
A CONTEMPORARY problem of rising speeds in the supersonic regime is how to get rid of the internally generated heat of electronic equipment in the high ambient temperatures associated with aerodynamic heating. At Mach 1 at 40,000ft, for example, aircraft skin temperature will stabilize at about 40 deg F, but at Mach 2 at the same height will rise to 250 deg F. Temperature, in fact, increases exponentially with speed, and at Mach 3 an aircraft's skin temperature will reach 630 deg F—and the air surrounding the electronic components will be at well above their maximum working temperature. The trend towards ever-smaller electronic components has not resulted in a corresponding reduction in the quantity of heat to be dissipated, and more watts have now to be dispersed in smaller spaces than ever before.

There are various ways of insulating equipment to provide the necessary temperature protection, all of which provide an artificial atmosphere in the electronic compartment. At speeds where the ambient temperature is low compared with that of the component, ram air can be used for blast cooling, or the temperature range can be extended by tapping bleed air from the engine compressor and cooling it before it is introduced into the equipment bay. Where ambient temperatures are high, it is sometimes possible to dissipate the generated heat by means of liquid cooling, and it is intended to make widespread use of the thermal inertia of the fuel in the tanks of aircraft or missiles for this purpose.

But particularly in missile application, where components have to be protected for a limited time, dynamic cooling may be difficult to apply and uneconomical from a weight and installation point of view. Another method, which has so far received only limited attention, is to make use of the latent heat of fusion of various compounds to absorb heat from the ambient atmosphere and from the components themselves. Some details of this system of "passive refrigeration" were recently given in a paper entitled *Protection of Electronic Components during High-temperature Transients using Heat-storage Materials* and read to the 1957 Electronic Components Symposium in Chicago by Mr. Duane M. Trones, who is a development engineer of the Minneapolis-Honeywell Regulator Company. Some use of this technique is now being made by the company.

The properties necessary for a storage material of this type (said Mr. Trones) are a high latent heat of fusion, good stability in temperature cycling, non-corrosiveness and low electrical conductivity; and it has been found from investigation that the organic compounds—principally the fatty acids, higher alcohols and fatty esters—are likely to be the best materials. An application was described in Mr. Trones' paper where a unit had been protected for 19 min at 350 deg F ambient, using only two ounces of storage material.

The principle of passive refrigeration is quite simple. The diagram on the left of Fig. 1 shows the condition where a protected unit with some internal heat dissipation is at its maximum steady-state operating temperature; the temperature profile would be as indicated. The internally-generated heat flows through the storage material, through the air film and out to the ambient air.



A miniaturized amplifier surrounded by heat-storage material. The can and outer shield are polished to reduce radiation, and separated by glass balls to reduce heat flow from conduction.

The difference between the ambient temperature T_a and the component temperature T_c is the gradient that will be experienced with the internally-generated heat flowing through the thermal resistance of the storage material and the air film. The particular insulating material used is chosen to have a melting temperature (T_f) just above the maximum operating temperature of the component. It will thus be solid as long as T_c is not exceeded.

If the ambient temperature is then suddenly raised to a new temperature T_a'—which exceeds the maximum operating temperature of the component—the profile will be as shown on the right of Fig. 1. Under these conditions the heat-storage material acts as a thermal reservoir accepting heat from the ambient air and also from the unit. The temperature of this material remains constant at the fusion point until it is completely melted, when it will have absorbed the total latent heat required to change its state. The component temperature will remain substantially at T_c while the storage material is being melted and this time represents the period of protection that can be provided. It can readily be calculated. Fig. 2 shows the time-temperature relationship during this period with step increases and decreases of temperature such as might be encountered by an aircraft which performed a high speed dash.

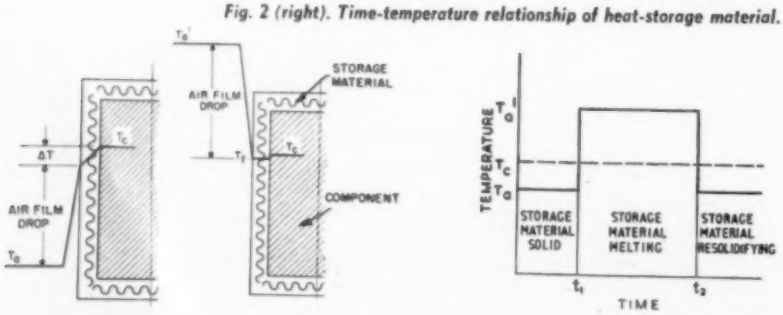
The heat pick-up from the ambient, Mr. Trones went on to say, is a function of conduction, convection and radiation. Taking as an example the protected unit shown in the photograph, he amplified each of these features. The conductive heat-flow is along the thermal bushings, the spacers between the shield and the can, and the air jacket, where gaseous conduction takes place. In the latter case, a layer of still air—one of the best insulators provided by nature—blankets the major part of the can. Heat is transferred from the ambient to the shield and also to the bottom of the can by convection, but there is no convection path from the shield to the can. The air jacket set-up by the radiation shield is too thin to allow convective currents and attenuates both conductive and convective heat flow. To reduce the radiation emissivity factor the shield and the can of the unit are chrome-plated and polished.

The maximum temperature that the unit can stand indefinitely without any melting of the storage material is 200 deg F, but it was found that the component temperature could be held practically constant at 350 deg F for 19 min, and at 500 deg F for nine min. Greater protection times may be expected at higher altitudes, because the heat-pick-up due to convection would be reduced. A minor snag is that the radiation shield depresses the maximum allowable ambient in the normal operating range.

The advantages of heat-storage high-temperature protection, Mr. Trones concluded, were that it was inexpensive, since common chemicals costing an insignificant amount of the cost of the protected equipment could be used; that it was non-expendable and could be used repeatedly without refilling; and that it was self-contained and did not require auxiliary equipment that would take up valuable space and add to the weight.

Fig. 1 (left). Temperature profiles at low and high ambient temperatures.

Fig. 2 (right). Time-temperature relationship of heat-storage material.



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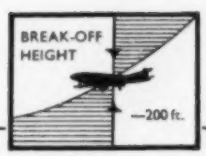

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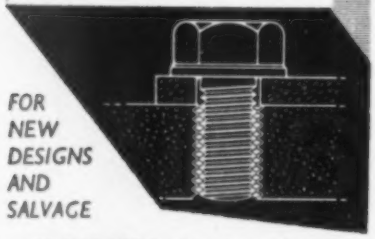

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